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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

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Electric Furnaces in the Brass Foundry.

The average foundryman has not studied the question of electric furnaces sufficiently, probably because the name is too comprehensive. He is well aware that a 60-ton Siemens furnace and a laboratory muffle furnace are both gas furnaces, and realises that there is little to connect the two types. He does not, however, realise that electric furnaces are in every way comparable to the conditions just instanced for gas furnaces, only with much greater shades of difference. Thus, appearing in this general category of electric furnaces are electric high furnaces for making pig-iron, electric steel furnaces up to 60 tons capacity for refining steel, electric non-ferrous furnaces, and baby laboratory resistance furnaces. All these are as different as chalk and cheese. Obviously, to refer to an electric furnace means nothing, and even when narrowed down to electric steel or electric non-ferrous furnaces, the term is totally unfit for any generalities. At one time there were as many induction furnaces working on steel as there were direct arc. To-day, so far as steel furnaces are concerned, the latter have become practically extinct. In the non-ferrous industry the electric furnace is now more important, in a relative sense, than in the steel trades, if a mondial review is taken.

These opening remarks have been written with the object of removing from the mind of the non-ferrous foundryman any preconceived notions on the subject of electric furnaces, because, as a class, no basis for comparison exists. Comparisons can only be made for individual types of furnace. Electric furnaces have been installed very extensively in the United States, but only to a limited extent in Great Britain, and it may be useful to examine the reasons. Primarily there is the relatively low cost of melting compared with the cost of stock. Roughly speaking, melting costs are twenty times more important in the steel-castings industry, when reduced to electric melting costs per pound in the ladle. Obviously melting costs assume less importance in the non-ferrous foundry, being overshadowed by the vagaries of the metal market. Secondly, the firms have not confidence that their staff have the requisite technical skill to handle an electric furnace; and, thirdly, they have not been convinced that they would not be experimenting for the designer at their own cost. Fourthly, there is the question of capacity and variety of output, the nature of the work turned out in the foundry being such that so many different mixes of metal are used that one furnace is insufficient to meet the needs. Finally, the question has been studied on a mere cost basis, without reference to quality, and with little thought to the advantages introduced. The advantages associated with the electric melting of non-ferrous alloys are that metal losses and labour costs are reduced and production is increased, and, what is of more importance, the working conditions surrounding the furnaces, providing a suitable type of furnace is chosen, are much healthier. There are many technical advantages, such as the improved temperature, furnace atmosphere, and composition control, all of which are of basic importance. The elimination of crucibles is a further factor.

Unfortunately, electric *steel* furnaces are useless for the brassfounder, otherwise he would have a wealth of experience available for their construction and manipulation. However, steel furnaces are only applicable to those non-ferrous alloys having high melting points, such as cupro nickel, Monel metal and the like.

In order that foundrymen may realise the commercial importance of this question, they should realise that there were installed in the United States at the beginning of 1922 more than 400 furnaces, whilst in Great Britain we doubt whether there are more than a dozen in commercial operation to-day.

MR. ALFRED BARNSLEY, of Halesowen Road, Netherton, near Dudley, senior director of John Barnsley & Sons, Limited, engineers and ironfounders, Netherton, who died on October 28 last, left estate of the gross value of £8,658, with net personalty £7,909.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Test Bars.

To the Editor of The Foundry Trade Journal.

Sir,—I have read with great interest the contribution by a "Member" in your issue of February 22, and your leader on the above subject in this week's issue. With many points raised by "Member," our committee are in agreement with his conclusions. On others there is a divided opinion, which must be settled before the specification receives official sanction.

There is one method mentioned by "Member" which, personally, I have found of great value, and I was unaware that anyone else was employing a somewhat similar test. That is the use of a block cast from the same ladle to show the structure of the iron, apart from its analysis. In our case we use the ordinary chill test, and not blocks of various thickness.

Coming now to your leader. First let me thank you for the position you have taken up with regard to complaints after the specification is once issued. Ample opportunity will be given for discussion. I also endorse your remarks stating how welcome any *constructive* criticism will be. I say constructive, because a mere opinion, not backed up by actual experimental knowledge, is of little use. When I tell you that the Scottish Branch alone, under the direction of Professor Cameron, have carried out more than 300 actual tests, costing a large sum of money, it is not much use putting forward mere conjectures.

With regard to the latter part of your article, as new and more assured tests are discovered, the specification will need to be revised either by the present committee or a new one formed for the purpose. Our work, as laid down by the Council at Coventry in March, 1919, and at York, November, 1921, was to submit a specification to the B.E.S.A., voicing the views of foundrymen in relation to the tests already in use. To protest against the issuing of specifications containing complete chemical analyses and physical tests, at all events until our knowledge of the effects of composition is better understood than at present. To enable comparisons to be made between results obtained on one shop with another, because each was using the same size test-bar made under similar conditions.

Taking the points at issue in the order named, the tests asked for in cast iron are the tensile test, the transverse test, with the deflection of the latter. The size of the tensile bar varies from 5/16 in. dia. in the 104A R.A.F., to 1.128 in. dia. in the B.E.S.A. for pipes. Many foundrymen are to blame for publishing great breaking loads (up to 21 tons) without giving the size of the bar used. I have quoted before where a firm regularly obtain 17 tons on the 5/16-in. dia. bar, but when compelled to use the ⅜-in. dia. bar, turned down to 0.564 in. dia. in the centre, only averaged 13 tons from the same mixture. A further drop in the breaking load to about 9 tons took place when the 1.128-in. bar was tried. This does not mean that a greater load than 13 tons could not be obtained on a 0.564-in. dia. bar if a different mixture was used. Take the engineers' specifications. I have before me an order for two chilled rolls for the Admiralty. The tests asked for are their usual transverse 1-in. sq. bar tested at 12-in. centres to give 2,000 lbs. The tensile to give 9 tons, presumably on a bar 0.564-in. dia. in the centre. Any mixture I may use to give me an inch chill on these rolls will give me white test bars, and the tests asked for cannot be obtained. The tensile will be obtained if I cast the bar 2.2 in. dia. and turn down to 1.8 in. in the centre, simply because with this size bar I obtain a close grey structure. Again, within a few miles of this city a firm are making a large number of castings for the Crown Agents. These castings are ⅝-in. thick, and have to be drilled and machined. The tests asked for are: Transverse, 2 in. × 1 in. × 36 in. centres to give 28 cwts.; tensile, 1.128 dia. in centre to give 9 tons. There is not much difficulty in obtaining the above tests, but the mixture employed renders the ⅝-in. thick casting too hard, and many of them have to be annealed before they are commercially drillable. The engineer of the largest U.D.C. recently asked for some compressor head castings averaging 5 in. thick; specified the same tests as the last case. If the metal in this case was most suitable for the test on the bars, the structure of the compressor heads would be an open, weak one, and a tensile bar would not give 7 tons if cut out of the casting.

Complete Chemical Specifications.—No foundryman is opposed to chemical analysis; its use is of the greatest service. What they *do* object to is to work to a given analysis, and be asked also to obtain certain physical results. Does the engineer suppose that the analysis given is the most suitable for the work, supposing the tests were obtained? If so, his knowledge is greater than many metallurgical chemists and foundrymen. One has only to glance through a few years of your excellent Journal to see the widely divergent views held as to the best analysis for Diesel work, and this by experts. Take the chilled roll trade. In America they believe in a low sulphur, low silicon chill. We in this country use a moderately high sulphur, medium silicon, to obtain the same result. (No cold blast furnace in this country can give us the 0.04 per cent. sulphur together with the low silicon.) On the Continent they depend on a high manganese and a low silicon and sulphur to obtain the same chill. Who is going to say which is best? They all satisfy large countries. The present duties of our committee are to redress these anomalies, and put forward a specification that we can work to in comfort and with satisfaction to our customers. Those of us who have to conform to present-day tests cannot wait years before they are revised in accordance with our present knowledge. If the "Fremont" or other methods of testing after practical tests over a period prove to be better, and as our knowledge of the effects of composition on strength and structure of cast iron advances, the present specification could again be brought into line with the new facts. The Council of the B.E.S.A. are always willing to do this once they are convinced it is to the best interests of manufacturer and customer.—Yours, etc.,

J. Shaw.

39, Montgomery Road, Sheffield.
March 12, 1923.

Book Review.

"The Journal of the Institute of Metals," Vol. 28. Cloth pp. ix + 1,010, with 37 plates and numerous figures in the text. Edited by G. Shaw Scott, M.Sc. (1922. London: Institute of Metals, 36-38, Victoria Street, S.W.1. Price 31s. 6d. net.)

"The Journal of the Institute of Metals" has now become a very substantial volume, the latest issue covering over a thousand pages, this being several hundred pages more than any previous volume. The increase in size appears to be due to three causes: Firstly, to the large number of Papers contained in Section I., which consists of the official minutes of proceedings of the Institute and covers five hundred pages; secondly, to the greatly enlarged Section II., which embodies over four hundred pages of abstracts of metallurgical and allied papers published throughout the world; and thirdly, to the very full index, which contains over five thousand entries, a fact which alone gives an idea of the comprehensive character of the new Journal.

A valuable new feature to be noted in Section II. is a detailed list of many hundreds of the world's metallurgical and allied periodicals. The publisher's name and address of each of these periodicals is given, together with the price and date of publication. A list of such completeness has not hitherto been available, and metallurgical workers should find it invaluable. Incidentally, it might be remarked that all these hundreds of papers are regularly searched by the Institute's staff of abstractors, the result of whose work is embodied in Section II. of the Journal, making this very much more complete and full than has previously been the case.

Mr. Vincent C. Faulkner, Hon. Secretary of the London Branch of the I.B.F., is lecturing to-morrow night on the subject of "Electric Furnaces" before the Paris Section of the French Foundrymen's Association.

The Influence of Dissolved or Occluded Gases in Cast-Iron.

By a Metallurgical Correspondent.

Molten metals possess the power of absorbing or dissolving quantities of various gases, and it is well known that most metals and alloys are capable of retaining gases dissolved in them in the solid state. The liberation of gases from solid steel when drilled under water has been demonstrated, and is now a familiar experiment. Under certain circumstances it has been shown that the dissolved gases in metal, particularly in iron and steel, exert considerable influence on the mechanical properties. Robert Austen demonstrated the embrittling action of dissolved hydrogen in steel* and the influence of nitrogen on the mechanical properties of steel have been studied by the Russian investigator Tschewski. Probably the most vital influence of dissolved gases on metals and alloys is their influence in promoting unsoundness in castings. This aspect has been known for a long time, particularly in the steel industry. The extensive systematic investigations of Brinell† have shown conclusively that unsoundness in steel ingots is to be attributed to the dissolved gas-content of the steel.

The earliest instance of the absorption of large quantities of gases by solid metals is the case of the metal galladium, which was found to be capable of absorbing many times its own volume of hydrogen. Considerable thought and discussion has been devoted to the consideration of the actual condition of the gases so absorbed in metals. Whilst complete agreement has not yet been reached as to the actual condition of gases so absorbed in metals, it is legitimate for metallurgical purposes to look upon these phenomena as cases of simple solution of the gases in the solid metals. The term "occluded gases" has been used to distinguish these from other absorption phenomena. With the possible exception of those gases, oxygen and nitrogen, which are known to form definite compounds with iron which are themselves more or less soluble in iron, the gases found in ferrous alloys are to be considered as being occluded.

In so far as cast iron is concerned, the influence of certain dissolved gases has been widely considered to have very marked effect in lowering the strength properties of cast iron. In view of the importance of this it will be of value to summarise our existing knowledge of the influence of dissolved gases in cast iron.

Gases Present in Cast Iron.

Troost and Hautefeuille found that hydrogen was the principal gaseous constituent of cast iron, and Herwig‡ states that the gases evolved during the solidification of molten pig-iron, after tapping from the blast furnace, include large quantities of carbon monoxide and hydrogen; white irons containing more hydrogen and hot blast grey irons more carbon monoxide.

Carpenter and Rugan§ in their extensive research on the Growth of Cast Irons after Repeated Heatings, examined the question of gases evolved from cast iron on heating to temperatures of round about 900 deg. C. *in vacuo*. In a cast iron of the following composition, CC, 3.38; Si, 6.14; Mn, 0.30; S, 0.010 and P 0.013 per cent., the composition of the gases evolved was as follows:—CO_2, nil; CO, nil; O, nil; H, 87.5 and N, 12.5 per cent.

It will be seen that the gases evolved consist solely of hydrogen and nitrogen roughly in the proportions of 7 : 1. The interesting observation was made in these experiments that the evolution of gas varied according to the position in the cast bar from which the sample was cut; less gas being evolved from the samples taken at points farthest removed from the gate. This fact had due significance in explaining the local cracking phenomena in certain of their fully "grown" samples. It is of importance to record here the composition of the gases obtained by Carpenter and Rugan from a piece of this same material after having been heated in contact with furnace gases under conditions at which maximum "growth" was found to occur. The bar previous to being subjected to growth conditions had been heated *in vacuo* until no further gas was evolved at 900 deg. C. The composition of the gases obtained after subjection to the growth conditions was as follows:—CO, 14.54; CO_2, 33.00; O, nil; H, 92.50 and N, 9.96 per cent.

In this case nearly half the total quantity of the gases was found to consist of the oxides of carbon.

A further sample of the gases taken from a normal low-silicon cast-bar of the following chemical composition, C, 3.98; Si, 1.07; Mn, 0.25; S, 0.016 and P, 0.133 per cent., gave the following results:—CO_2, 1.09; CO, nil; O, nil; H, 98.54 and N, 0.37 per cent.

In this case the gas was found to consist principally of hydrogen and a small quantity of CO_2 was also found.

The results obtained by Hailstone* show considerably larger percentages of oxides of carbon in the gas evolved. These results are detailed in full in the Table I.

TABLE I.—*Showing the Influence of Casting Temperature on the Gas Content.*

Sample No.	Casting Temp.	CCs gas evolved per gram. of sample	Constituents % CO_2	CO	H_2N_2 etc.
1	1428	0.402	0.98	29.62	69.40
2	1400	0.362	0.99	28.46	70.55
3	1390	0.310	1.21	28.25	70.54
4	1386	0.261	1.36	27.89	70.75
5	1361	0.206	1.61	26.46	71.93
6	1348	0.172	1.82	25.05	73.13
7	1330	0.126	2.32	24.76	72.92
8	1302	0.101	2.58	24.02	73.40
9	1272	0.085	2.96	23.78	73.26
10	1264	0.056	3.21	23.03	73.76

From these figures it will be apparent that the percentage of CO_2 decreases with the decreasing casting temperature of the sample. This increase appears to be largely at the expense of the carbon monoxide. The amount of gas evolved per gram of sample at the same time decreases with increasing casting temperature of the sample.

All these investigations agree that the principal gas present in cast iron is hydrogen. Carbon monoxide and carbon dioxide are also present in varying amounts, the significance of which will be discussed later.

The Influence of Dissolved Gases on the Properties of Cast Iron.

It is frequently inferred, if not distinctly stated, that the dissolved gases present in cast iron exert considerable influence, largely detrimental, on the properties of cast iron. These inferences have been made in statements describing the influence of the addition of small quantities of ferro-alloys which are known to form chemical compounds with certain of the gases present. We have, however, very little direct evidence of the influence of the occluded gases on the properties of the cast iron.

Oxygen in Cast Iron.

The gases present in cast iron which can be extracted by heating *in vacuo*, as already shown, are principally hydrogen, nitrogen and the oxides of carbon. Free oxygen is not met with in the gases collected from cast iron by this method. J. E. Johnson† (Junior), found the presence of oxygen and also nitrogen in both grey and white iron. This investigator does not discuss the condition in which the oxygen exists in the cast iron whether free or combined.

* Fifth Report Alloys Research Committee.
† J.I.S.I. No. 1. 1902.
‡ Stahl and Eisen. 1914.
§ J.I.S.I. 1909. No. 2.

* Carnegie Memoirs, J.I.S.I. 1916.
† Trans. American Institute of Mining Engineers. 1914.

Pickard* examined two samples of high-grade white irons, in which he found traces of oxygen amounting to 0.21 per cent. It is of importance carefully to consider certain of the features of Pickard's investigation. In the first place the samples investigated were two samples of chilled iron. This (0.21 per cent.) was stated to be "not so good" as sample No. 1, which contained 0.017 per cent. oxygen. An inspection of the two analyses given in Table II., for the purpose of comparison, will show that there are quite sufficient grounds other than the oxygen content to which the difference in quality for the specific purpose in view, that is chilled castings, can be attributed. Secondly, Pickard himself may be taken as considering this case to be somewhat unique. He states "that no sample of grey cast iron examined by himself or other investigators, except Johnson's special irons, has been found to contain oxygen up to 0.01 per cent. Thirdly, the oxygen found by Pickard was not free occluded oxygen and Pickard infers that it existed occluded in the iron as carbon monoxide.

Table II, *detailing the analyses of Irons used by Pickard*:—

Sample No.	1	2
C. C. ...	2.656	2.450
Gr. ...	0.550	0.797
Si. ...	0.615	0.699
S. ...	0.067	0.126
P. ...	0.198	0.207
N. ...	0.987	0.532
O. ...	0.017	0.021

All the existing evidence points to the fact that free oxygen does not exist in cast iron. The possibility of oxygen existing in cast iron as the oxides of carbon is confirmed by all investigators. The existence of oxygen in the form of metallic oxides dissolved or included in cast iron, apart from that which might be contained in any slag inclusions is still awaiting proof and no decisive evidence exists either way. Considered metallurgical opinion agrees that for all practical purposes oxygen cannot exist, in the presence of the large amounts of silicon in normal commercial cast irons, in the form of dissolved metallic oxides. It will now be quite clear that, as there is no free oxygen in cast iron, the question of the influence of oxygen in cast iron does not arise. If oxygen exists as the oxides of carbon or other oxides influence exerted on the properties of the iron by these oxides is surely the influence of the particular occluded or dissolved in the cast iron, then any oxide under consideration, not the influence of oxygen.

It is highly improbable that any oxides of iron can exist in solution in the iron in the presence of silicon. The conditions under which iron oxide can exist in conjunction with iron and silicide of iron, FeSi, are not known with certainty, and on this account a definite answer cannot be given to the opponents of this view.

Slag inclusions containing oxide will obviously exert their quota of influence in increasing the brittleness and decreasing the tensile strength according to their extent and disposition.

The only other oxides remaining, the oxides of carbon, require very careful consideration. Referring to the researches of Hailstone, already recorded, it is quite clear that the amount of these gases present varies with the casting temperature. The difficulty of attributing or apportioning any difference in physical properties found in any two samples of varying oxygen content to this feature or to the different cooling conditions arising from any difference in casting temperature, which might be looked upon as the cause of the difference in gas content, will be at once apparent. Knowing, as we do, the vital influence of the cooling conditions on the condition of the carbon in cast iron, we should be inclined to attribute at least the greater portion of the difference in physical properties to this cause. If the physical properties of Hailstone's series are considered, we find that the tensile strength varies from 10.98 tons in the bar with the highest casting temperature and the highest gas content, down to 5.24 tons per sq. in. in the bar with the lowest casting temperature and the lowest gas content. Further, the total oxygen content of the mixed gases is lower per unit volume of gas evolved in the lowest casting temperature and lowest tensile strength sample. It is also remarkable to find that the specific gravity decreases with lowering gas content and lowering casting temperature, and the soundness becomes steadily less in a like manner. We are, of course, unaware of the exact influence played by the oxides of carbon *per se;* but it has always been regarded that the primary cause of these phenomena is the casting temperature, and no data or investigations have yet shown that this belief should be altered.

The work of Johnson, so often quoted in this connection, was primarily inaugurated apparently to investigate the difference, and the cause of the difference, in the properties of hot-blast coke-smelted iron and cold-blast charcoal irons. As the influence of casting temperature was not considered, it will be obvious that it is impossible to attribute any direct influence to the oxygen *per se*.

Influence of Hydrogen.

We have no data on the influence of hydrogen on the properties of cast iron. The influence of this gas dissolved in steel in reducing the ductility and increasing the brittleness to a very marked degree has already been referred to. This action of hydrogen on steel has been investigated in a variety of ways since it was first announced by Roberts Austen. It is probable that the embrittling action of caustic soda and pickling baths on steel is due to this cause.

In an almost perfectly brittle material like cast iron it is difficult to see that any variation in hydrogen content could exert much influence on the brittleness. We have, however, never examined the properties of cast iron entirely free from hydrogen, and whether such cast iron would be more or less brittle than ordinary iron is a matter of conjecture.

Influence of Nitrogen.

The presence of this gas in steel as a compound of iron and nitrogen has been investigated of recent years, and its influence on the properties of steel is of a similar nature, though not so marked in extent as that of hydrogen. It is suspected that the nitrides of iron form a eutectoid constituent which is of a more or less brittle nature.

As regards the influence of nitrogen in this manner on the properties of cast iron, the same attitude must be taken as in the case of hydrogen.

As a result of experimental work, the alleged influence of certain of the more expensive ferro-alloys in improving the properties of cast iron, when added in small quantities as a result of their affinity for the dissolved nitrogen, has been disproved, and no great importance is now attached to this view.

Influence of Dissolved Gases on Soundness.

By far the most important influence of dissolved gases in metals is their influence on the soundness of castings made in the metals. The soundness of castings, whether as ingots or castings, is of fundamental importance in all metallurgical and engineering operations, and unsoundness is the most fruitful source of trouble in all these operations. The unsoundness takes the form of blowholes and porosity, and in the case of ferrous metals, cast iron and steel, the blowholes and porosity due to this cause more frequently present a bright unoxidised or at the most heat-tinted surfaces.

The conditions governing unsoundness in steel ingots has been closely studied for many years and the extensive investigations of Brinell are now familiar to metallurgists. During recent years considerable attention has been directed to the non-ferrous alloys, aluminium, brass and gun-metal. The unsoundness in gun-metal ingots was attributed to dissolved gases in the investigations of Carpenter and Elam.* In the case of cast iron considerable attention has been paid by a variety of workers to this aspect of the influence of dissolved gases.

The solubility curves of gases in industrial alloys are not known with any degree of accuracy; but as a general rule the solubility of the gases in alloys is much less in the solid state than in the liquid state. Consequently a marked change in the solubility of the gases is experienced during

* Carnegie Memoirs, J.I.S.I. 1916.

* Journal of the Institute of Metals. 1918.

the solidification range and a considerable evolution of dissolved gas is experienced by a solidifying alloy at this stage. If a liquid alloy has been prepared under such conditions as to be saturated with dissolved gases at the particular temperature of production, the cooling down of this alloy will be accompanied by a steady evolution of gas until the solidification point is reached, when an increased evolution will occur as a result of the change in solubility. If, on the other hand the liquid metal is not saturated with dissolved gases, then on cooling down the dissolved gases will be concentrated in the liquid portions of the alloy, which eventually reach their saturation point and commence to evolve gas at a rate depending upon the rate of cooling. When the solidification range is ultimately reached, an increased evolution of gas again takes place. Whichever set of circumstances occur, the grave risk of the evolved gases being entrapped in the solidifying metal does not need any elaboration.

Fortunately, it is quite possible, and, in fact, it is the general, in the case of cast iron to produce castings free from such unsoundness. It has been shown how important the casting temperature is in these phenomena, and as an example of this, amongst others, one need only refer to the previously mentioned work of Hailstone. It appears highly probable that the influence of the casting temperature is largely due, in turn, to its influence on the rate of cooling down to the completely-solid state, and it would appear that this should be sufficiently long in duration to allow the gases completely to escape through the liquid metal. In connection with this, we may remark that phosphoric irons, having a longer solidification period, are less liable to defects from these causes than low phosphoric irons and white irons, which have a much shorter solidification period.

In the case of steel the addition of strongly deoxidising materials, such as aluminium, ferro-titanium or silico-manganese, is a very effective means of improving the soundness of steel castings. Ironfounders by analogy have expected similar additions to cast iron to meet with equally satisfactory results. *It is extremely doubtful whether this is true*, and, as a matter of fact, the two cases are not exactly parallel. A large section of metallurgists now believe that the prime cause of blowholes in mild steel castings and ingots is the reaction between dissolved metallic oxides and the carbon in the steel. The addition of deoxidisers serves to eliminate the dissolved oxides, and consequently prevent the blowholes. It has already been stated that dissolved metallic oxides do not exist in cast iron, and in this sense the two cases are not parallel.

Whilst so little work has been done on the direct influence of gases dissolved in cast iron on its mechanical properties, it would appear on reviewing the work that has been done that their direct influence in this manner is not likely to prove serious or of much account. Indirectly, as one of the primary causes of the various types of unsoundness in castings, their influence is of considerable importance, and even in this connection it is fully proved that by suitable arrangement of the temperature conditions of casting the deleterious effects of dissolved gases for the most part can be avoided.

Gazette.

A PETITION for the winding-up of Cubitts' Engineering Company, Limited, has been lodged.

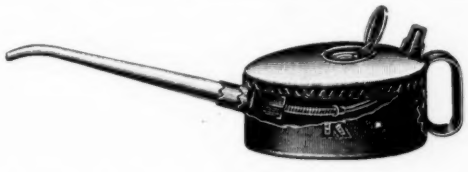
TRADING UNDER THE TITLE of the Wandsworth Engineering Works, J. G. Witcombe and F. C. Taylor, 30 and 32, High Street, Wandsworth, mechanical engineers, have dissolved partnership. December 1.

IN THE MATTER of the Hopyard Foundries Company, Limited, it has been resolved that the company be wound up voluntarily, Mr. J. A. Garland, C.A., 148, Edmund Street, Birmingham, being appointed liquidator.

A DECREE OF SEQUESTRATION has been granted in the case of the Paisley Brookfield Construction Company, 10, Collier Street Johnstone, engineers and contractors, and A. Stephens Jones & D. M'Intyre, individual partners. Claims by June 28. Agent, Mr. R. Risk, Johnstone, solicitor.

Kaye's Seamless Serrated Oilcan.

An oilcan is not a complicated piece of mechanism; but nevertheless a well-designed appliance for securing the proper lubrication of machinery cannot be arrived at in any haphazard fashion, and attention to apparently trivial details is essential to providing the best, even in oilcans. Messrs. Joseph Kaye & Sons, Limited, Lock Works, Leeds, for many years have specialised in these appliances, and from time to time have introduced minor improvements, which wide experience has proved to be essential. The rough usage to which oilcans are exposed led Messrs. Kaye & Sons to introduce serrated oilcans over 20 years ago, thus making them exceptionally robust. Other improvements include the oil-filter, which is an integral part of the feed-mechanism, as indicated in the sectional illustration. This arrangement prevents waste and other foreign material which may inadvertently get into the can, from finding its way into the parts to be lubricated.



A force-feed oilcan has been introduced, specially designed for oiling vehicular motor-haulage. This can has no filter, but it is capable of projecting an oil stream a distance of about 12 ft.

More Books on Foundry Practice.

Last week we published a list of some 25 books dealing with foundry practice. No books on the metallurgy of steel or iron was included. Through the kindness of Professor Campion and Messrs. Stobie and J. G. S. Primrose we are now in a position to amplify the list still further:—

GUN-METAL AND BRASSFOUNDING. By H. S. and J. S. G. Primrose. (Louis Cassier & Company, Bedford Street, London. 10s.)

FOUNDRY WORK. By B. Shaw and J. Edgar. (Sir Isaac Pitman & Sons, Limited, Parker Street, Kingsway, W.C.2. 2s. 6d.)

THE PRINCIPLES OF IRONFOUNDING. By R. Moldenke. (McGraw Hill Company. 30s.)

MALLEABLE CAST IRON. By S. Jones Parsons. (Constable & Company, 10, Orange Street, Leicester Square, London, W.C. 8s.)

MODERN FOUNDRY PRACTICE. By John Sharp. (E. and F. Spon, 57, Haymarket, S.W.1. 21s.)

OPEN-HEARTH STEEL CASTINGS. By W. M. Carr. (Penton Publishing Company, 2 and 3, Caxton House, S.W.1. 7s. 6d.)

FOUNDRY COST ACCOUNTING. By R. E. Beet. (Penton Publishing Company. $5.)

FOUNDRY PRACTICE. By Tate and Stone. (John Wiley & Sons. 8s. 6d.)

PRACTICAL PATTERN MAKING. By F. W. Barrows. (The Norman W. Henley Publishing Company, New York. 6s.)

PRINCIPLES AND PRACTICE OF IRONFOUNDING. By E. L. Rhead. (Scientific Publishing Company, Manchester. 7s. 6d.)

PRACTICAL ALLOYING. By J. F. Buchanan. (Penton Publishing Company. $5.)

THE CUPOLA FURNACE. By Edward Kirk. (E. and F. Spon. 15s.)

FOUNDRY IRONS. By Kirk. (Baird.)

THE STEEL FOUNDRY. By Hall. (McGraw Hill Company.)

LECTURES ON IRON FOUNDING. By Thos. Turner. (C. Griffin & Company, Exeter Street, Strand, W.C.2.)

New Krupp Concern in Berlin.—A new Krupp concern has been established in Berlin with a capital of 10,000,000 marks (about £100 at current exchange, but £500,000 at par), for the purpose of representing the firm's various factories in Eastern Europe.

Electrical Resistance Furnaces and their Uses.

Mr. C. R. Darling delivered a lecture before the Royal Society of Arts on February 7 on this subject. Sir Robert Hadfield presided.

Mr. Darling, at the outset, referred to the difficulties experienced by manufacturers in obtaining information with regard to electrical resistance furnaces, and considered it desirable to describe the various forms and their uses. After referring to the continually extending application of the electrical resistance furnace, he discussed its advantages, namely, the very small escape of heat (owing to there being no products of combustion formed), the clean atmosphere, the accuracy and ease with which it could be controlled so as to maintain steady temperature, and the fact that skilled labour is not necessary. Owing to the amount of heat which escaped being small, a small enclosure could be heated more economically by electricity than by gas, although the cost of 1 therm (100,000 B.Th.U.) produced by electricity at 1d. per unit was three times as great as that involved by burning gas at 10d. per therm. When the enclosure was large enough to allow of the gas being burned internally, so that the exterior might be lagged, the thermal costs might then be in favour of gas, but the impurities in the gas often made internal firing by this means objectionable.

Dealing with metal-wound furnaces, he referred to the laboratory furnace introduced by Heræus in 1902, consisting of a porcelain refractory tube round which a strip of platinum foil was wound in spiral form. One of the drawbacks to the use of this was that, if placed directly across the power mains, arcing was likely to occur, resulting in the burning out of the winding. Therefore, it was necessary to use an external resistance in the circuit to reduce current at starting, and gradually to cut out this resistance as the temperature rose, thus wasting time and current. In spite of this defect, however, the platinum-wound furnace was found to be preferable to gas heating for many purposes, and is still used for temperatures between 1,000 and 1,500 deg. C. The high cost of platinum restricted the size of these furnaces to dimensions too small for industrial processes. Any material present in the refractory tube which attacked the platinum caused the winding to fuse, and alundum is probably the best material at present available for the tubes. After referring to the developments leading up to the adoption of nickel chrome-wound furnaces with porcelain tubes, Mr. Darling said that the chief factor in the great development since attained by metal-wound furnaces was the introduction of nickel-chromium alloys. These could be heated for long periods to 1,000 deg. C. without oxidising or undergoing other deterioration, and offered a nearly constant resistance to electricity at all temperatures, so that a furnace wound with such material could be coupled directly to mains without danger of burning out. It was quite safe to say that metal-wound furnaces would never have found a place in industry had not these alloys, or others possessing similar properties, been discovered.

Mr. Darling then described, with the aid of lantern slides, some typical examples of modern commercial nickel-chromium furnaces. Although the safe continuous working temperature of these did not exceed 1,000 deg. C., the number of uses to which they could be applied was great. For instance, they were used in the laboratory for experimental work on the heat treatment of metals, for incinerations and chemical combustions, standardising pyrometers, etc., and in the workshop for hardening and tempering carbon-steel articles, such as dies, punches, milling cutters, gear wheels, taps, gauges, and smaller objects. In some of the large American factories batteries of these furnaces were used for hardening gear wheels and other parts of machinery, the objects being heated to about 10 per cent. above the recalescence point, and then allowed to quench in a bath placed immediately beneath the furnace. This procedure ensured uniform results, and was cleanly and cheaper to operate than gas heating. The nickel-chromium furnace is worthy of a much wider application in this country than it has yet received.

Internally-Wound Furnaces.

Mr. Darling pointed out that, although this arrangement was efficient, it could only be applied in cases in which the winding was not liable to damage from impact with the articles undergoing treatment. In connection with metal-wound furnaces generally, there was the question of the relation between the temperatures of an external winding and the interior walls. On starting from the cold, the difference between these temperatures was considerable, but when a steady condition had been reached, in the region of 900 deg. C., this difference was only about 10 deg. C., as shown by Barfield's experiments. Thus, the interior of a furnace could be raised to a temperature approaching the safety point of the winding without risk of a burn-out.

Up to the present no generally satisfactory metal-wound furnace had been designed for continuous use above 1,000 deg. C., or, at the outside limit, 1,100 deg. C. The need for a furnace for the treatment of high-speed steel, involving temperatures between 1,300 deg. and 1,400 deg. C., was generally recognised, but no metal or alloy had yet been found entirely suitable. Higher temperatures still were required for the annealing of the tungsten wire used for electric lamps, and what was really wanted was a cheap alloy capable of withstanding 1,800 deg. C. without oxidising, and which will have a low temperature co-efficient for electricity. Any metallurgist who would discover that would cause a big boom straight away in electrical furnaces. The cost of platinum and kindred metals, such as iridium, was too great to permit of their use for this purpose, and the metals of the highest melting points, such as molybdenum (2,600 deg. C.) and tungsten (3,200 deg. C.), although fairly cheap, oxidised rapidly in air. The annealing of tungsten wire was carried out in furnaces wound with molybdenum or tungsten, arrangements being made to maintain an atmosphere of hydrogen throughout the furnace —a troublesome procedure which must always act as a deterrent to their general adoption. Owing to the high temperature co-efficient of these metals, care must be exercised when starting from the cold, so that an unduly large current was not passed through the windings. Mr. Darling believed that such an alloy as he had suggested could be made, because there were materials which melted well above 2,000 deg., and it was only a question of getting the right alloy to enable one to get a furnace which would treat high-speed steel in the workshop just as easily as the nickel-chromium furnace would treat carbon steel. Many people were working on the production of this alloy, and their efforts were fairly certain to be crowned with success.

With regard to suitable refractory materials for high temperature work, if we had to work at temperatures of 1,700 and 1,800 deg. C. we must have a refractory that would stand up to the work. At present ordinary refractories were not satisfactory, and we were very badly in need of some refractory which could be made easily and would not show signs of deterioration at very high temperatures. The best at present were the carborundum refractories, but there appeared to be difficulty in making them on such a scale and with such certainty as was needed for high temperature furnaces. The solution probably lay in the direction of zirconia or magnesia, or a mixture of the two.

Carbon Resistance Furnaces.

The three chief types of these are (1) tube furnaces; (2) granular carbon furnaces; and (3) furnaces in which the refractory chamber was heated by carbon rods or strips through which the current circulated. With regard to the carbon-tube furnace, useful for special operations demanding a temperature of 2,000 to 2,500 deg. C., he described this, and pointed out that a special source of current was needed owing to the low resistance of the tube, through which the current might be 100 amperes at a pressure of 10 volts. This involved the use of a special transformer when the furnace was operated from ordinary A.C. mains. Obviously, such a device was unsuited to general

operations. Greater simplification was needed before tube furnaces could be used in workshop routine. Mr. Darling then illustrated a granular carbon furnace, in which the current was passed through a layer of carbon particles (of a size retained on a 20-mesh sieve) which surrounded the refractory chamber, intended for the testing of refractory materials. For a heated length of 8 in. and a diameter of 2½ in., 10 kw. were required for a temperature of 1,700 deg. C., the current being 125 amps. and the voltage 80. This furnace could be used on 100-volt mains—although wastefully—by using an external resistance, and on mains specially provided for arc welding (70 or 80 volts), could be run with maximum economy. One of the chief defects of granular resistance was the tendency to irregular heating, owing to lack of uniformity in packing. To overcome this, furnaces had been made with a number of electrodes entering round the sides, and connected to switches, which enabled the current to pass between any given pair, so controlling the temperature in sections. Another drawback was the absence of a good refractory material which would withstand 2,000 deg. C.

The granular furnace possessed the advantage of cheapness, and the current strength was such that a transformer was not needed to reduce the voltage from suitable mains, so that a direct-current supply could be used. A form of furnace, due to Hancock, consisting of a number of carbon rods in series, running along the outside of the refractory chamber, and forming a kind of cage round it, was then described. The ends of the separate rods were connected by graphite strips, and both were preserved from oxidation by covering with a carborundum composition, highly compressing, and then baking at a high temperature. Carbon treated in this manner was highly resistant to oxidation, and by using a number of rods in series sufficient resistance could be built up to enable the furnace to be attached to mains. A furnace of 4 in. diameter, with 14 in. of heated length, consumed 5 kw. at 1,000 deg. C., and 8 at 1,500 deg. C., and with a satisfactory refractory a temperature of 2,000 deg. C. could be obtained. This furnace appeared to be the best at present available for the workshop treatment of high-speed steels, the prevention of oxidation of the carbon being overcome without the uses of special gases or vacuum pumps.

Auxiliary Appliances.

Dealing with appliances used in conjunction with resistance furnaces, Mr. Darling said that a very useful addition to a furnace used for hardening carbon steel was some form of magnetic detector. Experience had shown that the best temperature at which to remove an article for quenching was that at which demagnetisation was just complete, which was somewhat higher than that of decalescence, and as the loss of magnetic properties was not abrupt, a good magnetic detector should be capable of indicating the final stage of demagnetisation. It should, moreover, for general utility, be adapted for either a direct or an alternating current circuit. In order to show the loss of magnetic properties by steel when heated, Mr. Darling heated a steel wire by electricity. The wire expanded, but when the current was switched off it cooled to a point, then expanded again, and ultimately cooled completely. With the aid of a magnet he showed that the wire was non-magnetic when hot, but magnetic when cooled. Mr. Darling illustrated the Bastian indicator, which indicated by means of a compass needle when demagnetisation was reached. When steel was inserted into the furnace the needle was deflected, but, when demagnetisation commenced, the needle swung back, reaching its original position on completion. The Wild-Barfield indicator, for use with alternating current, consisting of a moving coil placed between the poles of an electromagnet, and carrying a pointer moving over a scale, was also described, as well as a detector which gave an audible signal when demagnetisation was complete, the latter being designed by the Hon. C. W. Stopford and the author. This indicator gave very good results, did not need watching, and was suited to either direct or alternating current.

In conclusion, Mr. Darling said that future developments of electrical resistance furnaces in workshop practice would largely depend upon cheap electricity, reliable refractories and improved heating elements.

DISCUSSION.

THE CHAIRMAN, referring to the steel which announced that it was demagnetised by ringing a bell, said that manganese steel would not behave in that manner, because if this were heated and cooled it did not change, so that it was important to know the composition of the material. Mr. Darling had not referred to the experiments of the American Crucible Company. A month ago he (Sir Robert) had seen them melt electrolytic iron, requiring a temperature of about 1,520 deg. C., in a marvellous manner. It was done by the latest method, with a special lining in the crucible, and it was wonderful to see electrolytic iron run quite as easily a fluid as cast iron. The carbon content before melting was 0.06, and after melting 0.08 per cent., and it was a creditable melting to take up so little carbon. He had recently had some interesting specimens, sent from Sweden by Dr. Westgren, of iron, nickel and cobalt, which had been melted with the cathode ray; that was a remarkable result. Emphasising how useful the electric furnace could be, he said that his firm had dealt with no less than 100,000 tons of steel turnings during the war, which otherwise would have been wasted. We should not produce cheap steel electrically, however, until we obtained cheap power; perhaps some day we should get energy at 0.5d. or 0.4d., or less, and then no doubt metallurgical operations must be carried on by electrical energy. Emphasising the importance of continued research, the Chairman said he was not afraid for this country if we could in the future make the progress that we had done in the past 25 or 30 years.

Electricity Cheaper for Hardening Steel.

MR. L. W. WILD said that silica was a very good refractory in furnaces of the sizes used in the laboratory, but was utterly impossible in really large sizes. Comparing the costs of electrical and gas operation, he said there was not the least doubt, with reasonable cost of current, that the electric furnace, for hardening steel and the like, cost less than gas heating for a similar output. In addition, a still greater saving was generally made in respect of the cost of labour, partly by using unskilled or semi-skilled labour and partly by obtaining a larger output per man. It was difficult to get comparisons, but when they were obtained they always favoured electricity. As to the upper limit of the resistance of nickel-chromium windings being 1,000 deg. C., for industrial purposes, he agreed, but in special cases, by using the very best quality wire, by slow heating up and careful nursing generally, one could work the laboratory furnace quite satisfactorily up to 1,200 deg. C. He was glad that Mr. Darling was so hopeful that we should have an alloy to withstand 1,800 deg. C. without oxidising, but the difficulty would be to obtain a refractory to go with it. Unfortunately, the refractory makers' usual method was to take a really refractory powder and stick it together with a small quantity of ordinary fireclay. This resulted in deformation, and a refractory made up in that way, if used at a temperature of 1,800 deg. C., would probably attack the alloy. He considered that a refractory which would be required for that work would be something of the nature of a pure alumina or pure zirconia, cintered together at its own natural cintering temperature without any additional bonding material. That, he believed, would come when the wire came. With regard to the use of demagnetisation detectors, the non-magnetic temperature was the right temperature to which any steel should be heated, no matter what the carbon content; it was also the right point for a good many of the alloy steels, but it failed to be of use where the amount of alloy became very large.

THE HON. C. W. STOPFORD, discussing the question of what materials could be brought into contact with the ordinary resistance wire, referred to a small laboratory furnace he had fitted up, in which he had used lagging largely consisting of mica. The nichrom wire was quite a good alloy, but the effect of the mica upon it was such that the life of the furnace was only three or four hours. He had never been able to find in writing

anything about the materials which could or could not be used with nichrom; one would think that makers of those alloys would give that information in their catalogues.

Mr. J. R. Hancock suggested that the alloy which would withstand 1,800 deg. C. without oxidising would be expensive, whereas in the carbon rod furnace the rods could be replaced at a cost of a few shillings in about 15 minutes, even while the furnace was hot.

Mr. S. Jones said that from his experience at Teddington and at the Royal Mint he believed ordinary refractories would be in evidence for a few years yet. In an experiment carried out at the Royal Mint on a crucible with a standard temperature of about 1,600 deg. C., when they tried to melt pieces of nickel, the crucible collapsed when the temperature reached about 900 deg. C. The crucible was made of magnesium oxide, and the cause was being investigated.

Clay Bonds for Carborundum Useless.

Mr. Walter Hancock agreed that the principle of using bonding clay with refractories such as the carborundum series was fatal, and pointed out that there were methods of agglomerating these carborundum refractories and making them self-bonding. Although there was a considerable feeling that clay refractories were distinctly unsatisfactory for some purposes, he did not know how they compared with, for example, silica, from the electrical point of view. In asking that more careful attention should be paid to the production of these refractories, he said that undoubtedly clay was ground as well as was practicable, but the grog was frequently added in a haphazard manner. More attention should be paid to the proportion of grog added and to the grain sizes.

Mr. N. Cameron said he had used a Heræus furnace for nearly seven years quite satisfactorily; it had been taken to pieces and re-wound on a number of occasions. Before the war his firm had a stock of Heræus refractory tubes, but when they were used up there was difficulty in replacing them. The tubes used were of a greenish colour, and substitutes had not been so satisfactory. The temperature at which this furnace worked was from 950 to 1,000 deg., but they could go beyond that by using nichrom wire put straight on to the Heræus tubes. When silica tubes and nichrom were used, however, the silica started to soften, and there was a combination of the nichrom wire with the silica. There was another furnace, about 35 ft. long, with 450 or 500 ft. of nichrom wire. This took 120 to 130 amperes, and had a maximum temperature of about 450 deg. This had given satisfaction for nearly 7 years without any replacements. The wire was hung in sections, shackled in great loops top and bottom, and wound backwards and forwards in great hairpins on either side as well as the bottom. That was used for annealing glass. He was particularly interested in furnaces for the treatment of molybdenum, tungsten and nickel. They used nichrom and closed silica tubes, which were about 5 ft. long and closed at one end. The metal was placed in the tubes and put into the furnace, being left there until the correct temperature was reached, after which they were brought out and immediately plunged into cold water, so that it was not necessary to wait for them to cool. Very little had been said as to nichrom strip *versus* round wire. He had found the round wire very much better than strip, because it was more durable, and, if it were possible to use two wires in parallel, it was more satisfactory than using one. An English firm had quoted him £19 for a small furnace; this was exorbitant, and he believed he could build it for about £5 or £6. Unless outside manufacturers were prepared to reduce prices he was afraid they would get no business from his firm.

The Author's Reply

Mr. Darling, referring to the new alloy he had suggested, said he had not got it up his sleeve. He had tried to get an alloy made of a definite composition of aluminium and nickel in atomic proportions. That had the very remarkable property of having a higher melting point than nickel or aluminium. The melting point of the alloy was about 1,600 deg., whereas that of pure nickel was about 1,450 deg Some time ago he had asked a number of people to make it, and they had promised to send him samples within a week, but he had not yet received them, and concluded that there must be some very great difficulty in making it. Referring to the high frequency furnace brought out by Dr. Northrup in America, with that a temperature of 2,000 deg. had been reached within two or three minutes, but there was difficulty in supplying the high-frequency current.

A hearty vote of thanks was accorded Mr. Darling at the conclusion of his lecture.

American Foundrymen's Association Convention Papers.

An interesting and well balanced technical programme has been arranged by the papers committee of the American Foundrymen's Association for the Cleveland convention, April 28 to May 3. Following the usual custom, sessions are being arranged to cover each branch of the foundry industry, and as special features, group meetings on moulding sand research, apprentice training and special developments in the foundry world, will be held. The Institution of British Foundrymen will submit a Paper on "British Foundry Practice, Ferrous and Non-Ferrous," by Dr. Percy Longmuir, director of the British Cast Iron Research Association. The Association Technique de Fonderie Francaise also will be represented. A partial list of technical papers and their authors, as given in a recent issue of the American "Foundry," is appended:—

"Aluminium Casting Alloys," by Robert J. Anderson, Bureau of Mines, Pittsburgh; "Melting Aluminium Alloys in the Electric Furnace," by T. F. Bailey, Electric Furnace Company, Salem, O.; "Casting Aluminium Radiator Fronts," by Joseph Greves, Alloy Foundry Machine Corporation, New Rochelle, N.Y.; "British Foundry Practice, Ferrous and Non-Ferrous," by Dr. Percy Longmuir, Institution of British Foundrymen; "Automobile Casting Practice," by H. B. Swan, Cadillac Motor Car Company, Detroit; "Carbon in Cast Iron," by J. W. Bolton, Niles Tool Works Company, Hamilton, O.; "Relation Between Plant Layout and Plant Cost," by L. M. Hansen, Chicago; "Comparison of Brass Melted in Open Flame, Crucible and Electric Furnaces," by Mr. Romanoff, Ohio Brass Company, Mansfield, O.; "Casting Bronze Tablets in a Commercial Foundry," by Jacob G. Kasjens, Brass Foundry Company, Peoria, Ill.; "Open Hearth Practice," by M. W. Carruthers, Westinghouse Electric & Manufacturing Company, East Pittsburgh; "Investigation of Core Sands," by C. S. Koch, Fort Pitt Steel Casting Company, McKeesport, Pa.; "Data on Re-use of Spent Moulding Sand," by F. L. Wolf and A. A. Grubb, Ohio Brass Company, Mansfield, O.; "Use of Oil as Fuel in Malleable Furnaces," by A. V. Landschoot, Iowa Malleable Iron Company, Fairfield; Ia.; "Hardening Malleable Castings," by Edwin K. Smith, Lake Side Malleable Iron Company, Racine, Wis.; "The Tunnel Kiln in Annealing Malleable Castings," by Philip Dressler, American Dressler Tunnel Kilns, Inc., Cleveland; "Pyrometers in Malleable Foundries," by H. Brewer; Leeds & Northrup Company, Chicago; "Data on Powdered Coal," by F. L. Wolf and W. Arrowood, Ohio Brass Company, Mansfield, O.; "Handling Scrap in a Malleable Plant," by E. D. Halsey, Terre Haute Malleable & Manufacturing Company, Terre Haute, Ind.; "Centrifugal Casting," by Leon Camen, New York; "Electric Grey Iron Casting," by L. J. Barton, Los Angeles, Cal.

In the course of a paper on "Stainless Steel," read by Mr. J. H. G. Monypenny, before a meeting of the Birmingham Metallurgical Society, the author remarked that the general properties of stainless steel and also its resistance to corrosion were influenced to a considerable extent by the heat-treatment which the steel had undergone. The material had the greatest resistance to corrosion when hardened, and the least when annealed. Cold-work decreased the non-corrodibility to a considerable extent.

A Practical Cost System for the Small or Medium-Sized Foundry.*

By Peter I. Hill, F.W.C.A.

(*Continued from page* 193.)

Uses of System for Purpose of Control of Expense and Selling.

Coming now to what is after all the most important part of any costing system, as unless full use is made of the information supplied, the compiling of cost data is of little service, being merely a record to be filed away and forgotten.

Standardisation.

There now exists full details of all materials used, wages paid and other expenses; also in a very concise form a report of the results obtained and the separate costs of the various elements, both in total and in ratio to the tonnage produced.

Cupola Charge.

At a glance there is all the information necessary to enable one to standardise mixtures so as to obtain the best results. The total charge representing 100 per cent., the various grades of pig iron and scrap used, are shown in the ratio percentage they bear to the total.

There is also the details of coke and limestone used and the average of each consumed per ton of iron melted.

Similarly, respecting the castings produced and scrap made, there is the separate tonnages and the ratio per cent. these bear to the weights charged into the cupola; the difference not accounted for by actual weights being the loss in melting, and so we have a full return of the 100 per cent. originally charged.

On the opposite side of the cost sheet there are the details of the costs per ton, both of the weights charged and after allowance is made for scrap returned, the melting costs are also shown, the coke, limestone and labour costs being separately stated. The costs are the average per ton on the produced weight and not on the weights charged into the cupola, the result being that it gives the cost of the metal as in the finished casting.

To the practical man this detail is most valuable for cost control and as a guide to efficiency. The condition of the market to-day is such that one can select exactly the class of raw material required, and although it does not follow that cheaper materials mean lower production costs, that is not the point to bear in mind, as results are the important consideration, and what the system enables one to do is to select such mixtures as give the best results, and these consistent with the lowest production costs.

Working Costs.

Too much importance cannot be attached to the fact that these are actual working costs, and consequently can be absolutely relied upon as representing the true conditions in the foundry. The cost sheet is compiled monthly, and the summaries showing the comparative costs month by month give the manager complete control. Not only does he see what one particular element is costing, but he can readily make whatever comparisons he desires with other elements, and so exercise a balancing effect. Without this it does happen that one sometimes concentrates on one particular element, with the result that the costs are seemingly reduced, but what has really happened is that some other element has been sacrificed and the costs increased in the process; consequently it is equally necessary that foundrymen should attach quite as much importance to fluctuations in cost, whether *up or down*, and investigate fully so as to determine the cause and apply whatever remedy is necessary.

Indirect Factory Expenses.

Establishment and General Charges.—In the working cost sheet these are averaged to show the cost per ton produced, but the allocation, when we come to determine the cost of a particular job, whether for the purpose of estimating or job costing, has to be otherwise considered. There are many ways by which these charges can be dealt with but in the foundry, the most satisfactory being an allocation partly on the basis of weight and partly on direct labour. In the system outlined this principle is, to a certain extent, carried out by means of a compromise, *i.e.*, included in the cost of iron, there is all the indirect labour necessary to the operation of the cupola, this being on the tonnage basis. The remaining indirect factory expenses, establishment and general charges, are allocated on the basis of direct labour, whilst the item of depreciation is added to the cost at a rate per ton. Respecting the section allocated on the direct labour base, there is the optional method of ratio per cent. or a rate per hour.

In the larger foundries, where the costs are distributed to departments, grades of castings, etc., it is advisable to go into greater detail, but small or medium-sized foundries, to which this system has particular reference, the basis outlined will be found quite satisfactory in practice.

The correct allocation of these charges is of primary importance, and here is a point where standardisation of method in the trade would be of real value. Take for example a job that could be done either by (*a*) journeyman labour, or by (*b*) apprentice labour; operating the ratio per cent. basis, even allowing for the fact that the apprentice might take longer on the job, the result would be that, in the case of the journeyman, the wages paid being higher, there is added considerably more for overhead expense when working off a flat percentage basis than one should do in the case of the lower paid apprentice, whereas actually the reverse might be the case from the viewpoint of actual cost. The apprentice, taking up the same floor area, really more in the sense that he occupies the space for a longer period, requires more supervision and so on. On the other hand, working from a flat-rate per hour and allowing for the fact that the apprentice would take longer over the job, considerably more is added to the work when done by the apprentice than by the journeyman. The latter method does tend to greater accuracy, equalising as it does the cost, when performed by different grades of workmen and youths; no doubt it presents a certain amount of difficulty when one comes to deal with the piece-worker, but this can be overcome. In cases where the men pour their own metal, due allowance has to be made for the time occupied as part of the direct labour cost of the job. This variation of method with different foundries possibly to some extent accounts for the widely differing prices being quoted to-day.

Summary of Cost and the Progressive Position.

In the final summary of cost there is now available exactly the information that is required by the directors, general and sales managers, etc., which are included in the chart (Fig. I.). Under the caption of total cost it includes (*a*) cost of iron at cupola spout; (*b*) cost of direct labour; (*c*) cost of indirect factory expenses; (*d*) cost of establishment and general charges; whilst the summary sets forth (1) weight of castings produced; (2) period worked and actual number of casts made; (3) the total direct labour hours and the average cost per hour for overhead expenses; (4) the total direct labour wages and the ratio percentage the overhead expenses bear to these.

The progressive position is also shown in summary form, and includes (1) total period worked to date; (2) total tonnage produced to date; (3) total cost to date; (4) estimated trading balance to date, subject to depreciation charges only.

Estimating and Costing.

Estimating.—For the purpose of estimating there is now a most reliable base on which to work. (*a*) Having determined the weight of the

* A Lecture delivered before the Lancashire Branch of the Institution of British Foundrymen, Mr. John Haigh in the chair.

casting to be quoted for, there is the price at which to charge the metal into the estimate. (*b*) The direct labour cost being determined, one knows exactly what requires to be added to provide for overhead expenses. (*c*) The estimated cost being a known quantity, it remains only to add the actual carriage that will be incurred, allowing for depreciation, interest on capital and profit.

Costing.—The same routine is followed excepting that there are *actual* records of weights and direct labour costs on which to base.

Stock Control.

The stock accounts operated as part of the system are also a valuable asset in the matter of control of stocks, enabling the foundryman to keep within limits both as regards weight and locked-up capital.

Development of the System.

The assumption throughout the Paper has been that in most cases the foundry is a self-contained unit, producing castings from customers' patterns, doing its own maintenance work and what pattern expense has been incurred has been to facilitate production undertaken at the expense of the foundry as a general charge on itself. Consequently there are several points on which the author will touch very briefly as an indication of the directions in which the system can be developed.

Pattern Making.—Pattern making undertaken for customers' requirements and at their expense should be treated outside the general production costs of the foundry, being charged to a separate set of accounts both for materials and labour. A pattern sales account is also operated distinct from the casting sales account.

Plant Expenditure.—Expenditure on plant, other than the general maintenance, repair and renewal, is an item of capital expense and does not come within the cost accounts. Also, any materials supplied from general stocks or labour expended on additions to plant should be similarly treated, being debited to capital account and credited to revenue account.

Departmental Costs.—Departmental costs or costs of groups of castings can be obtained without very great additional effort. This can be done by slight alterations in the analysis of the expense accounts and wages, the cost sheet to provide extra columns headed for departments and the items of expense being extended into the respective columns to which they refer.

In the case of foundries where machines are employed for moulding, it is necessary to deal with this as a separate department owing to the vastly varying conditions both as regards direct labour costs and overhead expenses.

The object in installing machines is to do by mechanical means work previously performed by hand; in effect to employ a machine instead of manual labour and by so doing to increase production and to reduce costs.

In the process the direct labour costs are reduced, but the overhead expenses in the ratio to the direct labour are increased as there is to take into account the expense of operating the machine, including power, fair wear and tear, special moulding boxes, etc.; this does not mean that the overhead cost chargeable to any particular casting is increased; on the contrary, it is probably reduced as, although the rate per hour or percentage on the direct labour cost is increased, there is a greater number of castings produced over which to spread the burden.

In the case of machine moulding, it is obvious that special provision has to be made, especially should we take into account the capital sum expended on the installation. One method by which the overhead expenses can be dealt with under such circumstances and where all machines are alike, is to determine a rate per hour per machine, such rate to include all charges other than the direct labour cost which are still used as the base. Where the machines differ in type, power, etc., a graduated rate based on the horse-power of the machine will be found satisfactory.

These are, however, matters which call for special consideration, but are mentioned as an indication of the possible development of the system to suit foundries of any size and under any conditions.

Determination of Manganese in Pig-Iron.*

Persulphate-Arsenite Method.

Five-hundredths to two-tenths gramme of the sample is transferred to a 100-c.c. flask, 15 c.c. of HNO_3 (sp. gr. 1.13) are added, and gentle heat is applied until the sample is decomposed. Five c.c. of a solution of ammonium persulphate are added, and the heating is continued until the combined carbon is completely oxidised. If graphitic carbon or silica separate in amount sufficient to render it necessary, the solution is filtered through a small filter paper, the filtrate being received in a flask similar to that previously used. The filter and residue are washed with the minimum of water or with 15 c.c. of $AgNO_3$ solution, which is required for the subsequent oxidation. The $AgNO_3$ solution is introduced either through the filter or to the unfiltered solution. 10 c.c. of ammonium persulphate solution are added, and heat is applied until the characteristic pink tint of the permanganic acid is well defined. The solution is then quickly cooled, when 10 c.c. of NaCl solution are added to decompose the silver nitrate. After stirring, standard sodium arsenite solution is added until one drop just dispels the pink tint of permanganic acid. The addition of sodium chloride solution is unnecessary if the solution of permanganic acid is quite cold and the titration is conducted rapidly; otherwise, the excess of persulphate will react upon the reduced manganese with a resultant recurring end point. The number of c.c. of the standard arsenite solution required multiplied by 0.1 gives the percentage of manganese in the sample.

If desired, a greater initial weight of the sample may be taken, when the solution thereof is diluted to a definite volume, the graphite and silica are allowed to subside and aliquot portions are withdrawn with a pipette.

Solutions Required.

Ammonium Persulphate Solution.

Ammonium persulphate	100	grammes
Water	1,000	c.c.

Silver Nitrate Solution.

Silver nitrate	1.3	grammes
Water	1,000	c.c

If desired for convenience, the silver nitrate may be added to the nitric acid solvent in the proper proportion.

Sodium Chloride Solution.

Sodium chloride ...	2.5	grammes
Water	1,000	c.c.

Standard Sodium Arsenite Solution.

Sodium arsenite	1.0	grammes
Water	1,000	c.c.

The sodium arsenite solution is standardised by means of a standard steel or iron of known Mn content. It is adjusted if necessary so that 1 c.c. is equal to 1-10 per cent. Mn based on the initial weight of the sample used.

Nitric Acid (Sp. Gr. 1.13).

Concentrated nitric acid	240 c.c.
Water	760 c.c.

THE POWER GAS ECONOMY COMPANY, 50, Wellington Street, Glasgow, have received orders for 57 "Hunter" gas burners since Christmas, for firing boilers and stoves. Among those who have placed orders are the Ebbw Vale Steel, Iron & Coal Company, Limited, Alfred Hickman, Limited (two orders), Frodingham Iron & Steel Company, Limited, John Lysaght, Limited, Ruggles Coles Rotary Dryers, Delauny Belville Boiler Company, and Charbonnages du Bois du Luc.

SMEETON-WRIGHT FURNACES, LIMITED, of 56, Victoria Street, London, S.W.1, have appointed T. H. Bullimore & Sons, Royal Arcade Chambers, 38, St. Mary's Street, Cardiff, as their sole agents in the South Wales district, and Mr. James Melling, 10, Sycamore Street, Sheffield, as sole agent for Sheffield and district, for the exploitation of their "Chantraine" patent furnaces and recuperators.

* A method used and published by the United States Steel Corporation.

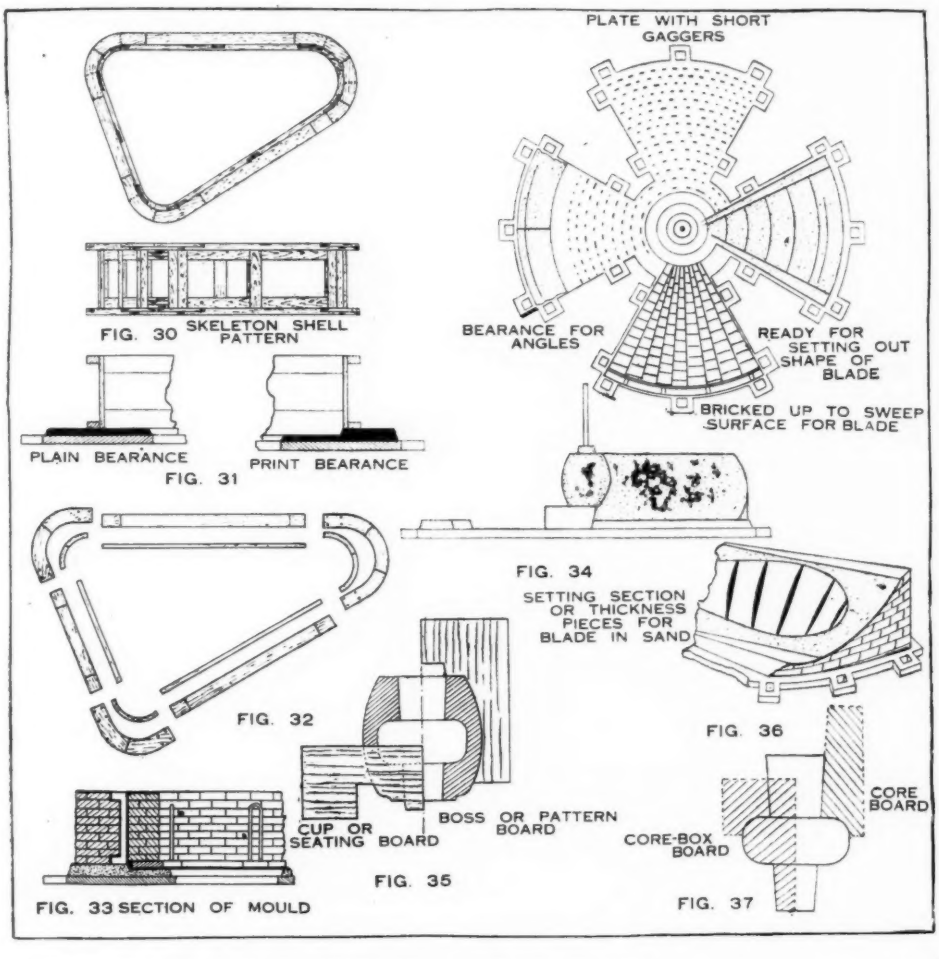
An Apprenticeship Course in Foundry Practice.—XXXIV.

By Ben Shaw and James Edgar.

LOAM MOULDING.

General Work.

While much space has been occupied in explaining the value of loam in preparing work that can be swept, it is not exclusively used for that purpose. In many foundries that specialise in loam work sweeping about spindles, whether vertically or horizontally, forms but a part of the work done and frequently a less important part. On the other hand, with the exception of large cores, other foundries only use loam for work that can be swept. The use of loam in the preparation of moulds for very large castings is considered by many to be the safest method for producing them sound. We do not endorse this opinion, because we believe that dry-sand moulds are equally as effective, and if we consider the moulds only, they are, as a rule, more economically made in dry sand. The fact remains, however, that the methods used in the production of similar castings vary very much in different foundries, some using loam while others use dry sand. This divergence of method is gradually being eliminated in favour of dry-sand moulding, because it is relatively cheaper and as a rule more quickly done. We refer particularly to large work that does not favour sweeping in loam. Anyone capable of taking a retrospective view of loam moulding, say over the last thirty years, will notice the tendency towards dry-sand moulding. Formerly practically all large work was made in loam. Large marine castings were invariably made in loam. There are still many foundries that continue to make reciprocating cylinders, crown-down in loam, whereas in others these castings are made crown-up in dry-sand moulds and they can be produced in about half the time that is occupied in using loam. Casting a cylinder crown-down is, of course, likely to produce a sounder casting, because the open end offers facilities for a head, and this method should be adopted for special work. But dry sand is equally applicable when casting crown-down is desirable, although a combination of loam and dry sand is more effective, as then the base of the mould can be prepared in loam on a plate. The use of loam for any large moulds is frequently determined by the pattern supplied.



Patterns for Loam Work.

When it is desired that castings should be made in loam, the patterns should be made to suit that class of moulding and a pattern having a solid exterior should not be supplied. A pattern having a solid exterior would invariably be used in dry sand, but if for some reason the mould is made in loam, the pattern is not only likely to suffer considerably in the process but it increases the difficulties of the moulder. The wood absorbs moisture and swells in contact with the wet loam, and in order to facilitate stripping both mould and pattern are stoved to dry the mould. This of course affects the pattern, and the wood shrinks and incidentally the heat tends to draw resinous matter in the wood to the surface, which is absorbed by the loam and causes a bad strip.

Much care must be exercised on the loam surface after the pattern is removed, because it is likely to shell off or scale in places that have been in contact with knots in the wood. Patterns for work to be made in loam should have the minimum of wood in their formation to give the required shape and to be conveniently rigid to keep their shape. They do not need to be so strongly constructed as those that are to be used in sand, because they have not to withstand the pressure of ramming. Either a framed or skeleton pattern in the most suitable form of pattern for loam or that form of pattern frequently referred to as a skeleton shell pattern. It is the latter that offers special advantages to the use of loam, as many of the cores necessary can be made with the mould, and consequently the thickness of metal in the resulting casting is more likely to be reliable.

Moulding from a Skeleton Shell Pattern.

An illustration of a suitable form of pattern for the water end of a heart-shaped uniflux condenser is shown in Fig. 30. Only the main shape is shown, the subsidiary parts, such as branches and division plate, being eliminated. Because of the fragile nature of the pattern, a prepared bed is necessary on which the pattern is laid. This bed is of loam and prepared on a plate which is used as a foundation for the mould. A loam bearance is prepared in a manner similar to the method used in making a sand bearance, but as a rule, iron rods about $1\frac{1}{4}$ in. sq. are used as logs. They must be straight and set level on a plate, and in the same horizontal plane at such a height from the plate that the top edges are above the height of the short gaggers cast on the plate. Loam is applied to the plate which has been previously claywashed and strickled with a straightedge to conform with the iron rods. When completed, the rods are removed and the spaces made up to form a continuous level surface. The whole is then dried or allowed to become stiff before the pattern is located on it. In work of this kind either the core or cope must be prepared for lifting, rarely both. Usually it is more convenient to lift the core and make minor lifts in the form of drawbacks about the cope to suit the branches and other subsidiary parts that may need a joint below the top surface. When the core is to be lifted and the area in contact with the bearance is large, no print need be formed, the core being finally located by measurement when the mould is being assembled. In such cases, therefore, the pattern may be set directly on the bearance. If a print is desirable, the pattern should be located on the bearance while the loam is green, and the bearance following the inside shape recessed to form a print. The two methods are shown in Fig. 31.

Invariably, though not always, the core is made first and a bottom lifting-plate is necessary. This is bedded in loam applied to the bearance and the core built upon it, using bricks and loam until the surface is made flush with the pattern. About the sides and between the pattern-frames loam is applied and strickled to follow the inside shape of the pattern. The strickle is checked to ride on the outside of the pattern, the checks are therefore equal to the thickness of the metal required. When the loam is sufficiently stiffened to continue the work a solid exterior is given to the pattern by using ordinary floor-sand to fill the spaces between the frames of the pattern, and this is sleeked off before the mould is commenced. During the process screws that secured the various frames of the pattern are removed, the pattern being dissembled in the manner shown in Fig. 32. The building of the mould follows the method adopted for ordinary cylindrical work, bricks and loam being used, and if it is desired to cast the job on the floor, ring plates having gaggers cast about the outside are necessary to support the brickwork, although the completed mould may be enclosed in a sheath of wrought iron and sand rammed between it and the mould preparatory to casting. Ring-plates are then not as necessary. When it is intended to bed the mould in the floor and ram sand about it—a practice frequently adopted—the brickwork does not need further support. A section of both core and mould is illustrated in Fig. 33. When the top surface of the mould is level, the cover may be made separately on a suitable plate or a good covering of loam may be applied over the surface and a plate bedded on it. The loam surrounding a few convenient places about the joint of the mould with the cover should be sleeked and marked to indicate the relative position, so that when the cover has been lifted during the process of stripping it can be returned to its correct position for casting. Loam is better than either green or dry sand for patterns of this type, because the sand needs some support during the time of ramming, whereas loam needs no subsequent ramming after it is applied.

Loam Moulds for Propellers.

A propeller is a type of casting which can be conveniently produced in loam and for which the pattern work necessary is limited to a few boards and some thin sectional pieces representing the section of a blade at known distances from the centre. Although in the matter of speciality work it is a good example of a type of casting that is invariably made in loam irrespective of the district and whether in cast iron, bronze, or steel. This is an example of work for which the making of the mould embraces a number of distinct operations and furnishes an illustration of the use of various methods in combination. The method of preparing the mould may vary slightly according to whether the face of each blade forms part of a true screw or one of varying pitch, and the boss may be prepared at a greater distance above the building plate in some instances than others, this depending upon the amount of "set back" of each blade. Although modifications are necessary to suit the particular kind of propeller, however they are usually made on the same principle. A substantial plate is the first essential required upon which the mould is to be built. The plan view in Fig. 34 illustrates the kind of plate suitable. A vertical spindle is required to which sweeping boards can be attached. A loam pattern representing the boss or hub is required to be swept, and for this purpose two boards are required as in Fig. 35. The first board to be used is the "cup" or seating board. This forms a part of the mould and a print for the centre core. The cup is filled temporarily when the loam pattern for the hub is built and the hub or pattern board gives the requisite shape. Sometimes the cup board is extended to sweep a bearance on the plate for setting the outside, from which the pitch of the blades is swept, but frequently a separate bearance board is used. This board should be so made that when properly set a mark is cut on the surface of the bearance to be used as a guide for setting the angle. Only a single angle is necessary when the propeller is required to have a regular pitch. This is set on the bearance to coincide with a previously marked centre line and weighted to maintain its position accurately. A balanced sweeping board is secured to a spider which rides on the angle. Its striking or sweeping edge radiates from the centre of the spindle and it is so arranged that it is capable of being worked over the surface required for each blade. Bricks and loam are used to build up the shape, and a loam surface is eventually strickled off when the angle is removed to the next part of the plate until the surfaces for the four blades are swept. As a rule the board used for this purpose is so prepared that it makes definite marks on the surfaces at regular distances from the vertical centre. These marks correspond with the concentric lines on the drawing on which the shape of the blades can be set out. When all surfaces are ready the whole is required to be dried before proceeding with the work. After being dried a centre line radiating from the vertical centre and determined from the drawing in relation to the hub is marked on each surface. From these centres and the concentric lines the correct shape of each blade can be readily marked out, and two pieces of iron about $\frac{3}{8}$ in. or $\frac{1}{2}$ in. sq. may be bent to rest flat on one surface and so shaped that they enclose the shape of a plate. Inside this shape a skeleton pattern is formed, sectional pieces, corresponding to the required shape of the blade at definite distances from the centre, are set in their respective places on the surface and between the iron rodding. The method is shown in Fig. 36.

Between these thin section pieces ordinary floor sand is rammed and strickled or sleeked off to follow the contour of the pieces, and in addition to form a fillet between the temporary blade and hub. When properly sleeked off, the section pieces are withdrawn and used in a similar manner on the next surface. This process is repeated until a complete temporary pattern is formed which can be covered. It is not necessary to explain the covering process in detail excepting to state that each blade is covered separately. A joint is required to be made on these covers and near to the boss pattern to form an opening when the boss is removed sufficiently large to admit the centre core. Loam is then applied over this and a cover plate bedded on it. When the whole job is again dried the cover is lifted and the temporary pattern removed. The centre core is usually swept about a vertical spindle for which a corebox board and top board are supplied, Fig. 37, but frequently such cores are made on a horizontal spindle. The core, therefore, is made in a similar manner to that described previously for other cores.

When a considerable body is made up with brickwork as in providing the shape for propeller blades, the brickwork at the back and away from the mould surface can be made very open in order to facilitate drying.

Loam, being strong, develops cracks on drying, and considerable care is necessary in filling them, as the pressure of gases generated when casting is likely to force loam or blacking from a badly-filled crack against the metal. The tang of a file is useful for cleaning out cracks, after which they should be swabbed and loam worked in preparatory to sleeking off and blackening. However carefully these cracks are attended to, veins are likely to appear on the casting, but these do not influence its quality as a whole.

Mechanical Appliances in the Foundry.

In our issue of March 1 we published an article bearing the above title. Since its appearance we have received from the author three more illustrations. Fig 1, which is a 4-ton per hour plant by Messrs. Thwaites, Limited, of Bradford, is referred to on page 172 under the subhead of "Methods of Charging Cupolas." Fig. 2 is further to illustrate this section, and is the system devised by M. Thomas, of A. Piat & Sons, of Soissons, France.

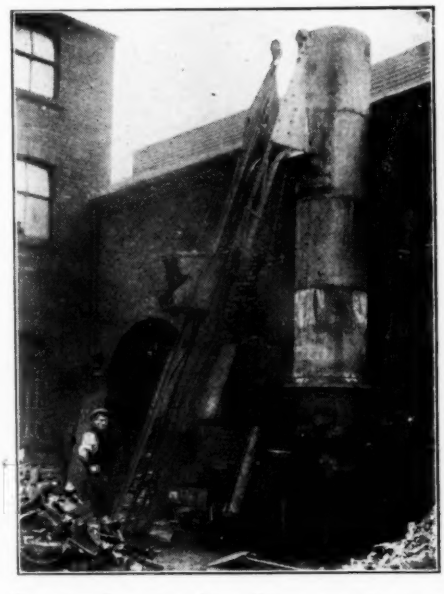


FIG. 1.—INCLINED SKIP HOIST FOR CHARGING CUPOLAS.

Fig. 3 illustrates Prof. Charnock's section dealing with the lay-out of foundry plant on the continuous casting system.

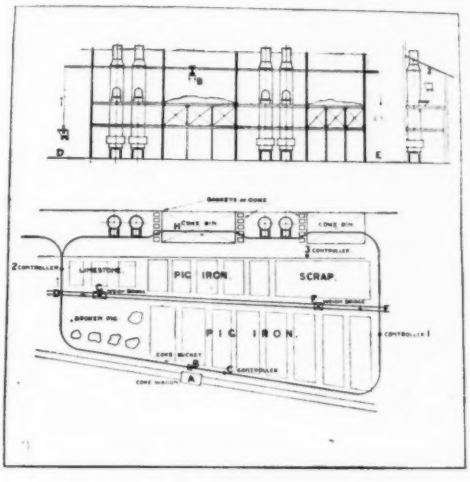


FIG. 2.—CUPOLA CHARGING ON THE RUNWAY SYSTEM.

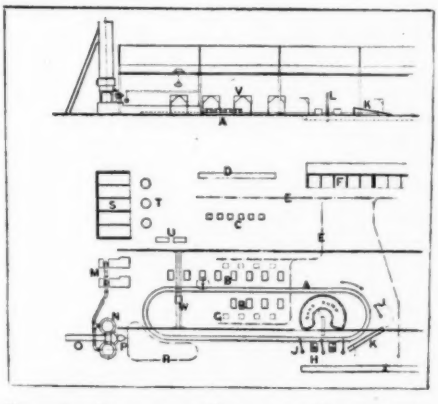


FIG. 3.—LAYOUT OF PLANT ON CONTINUOUS CASTING SYSTEM.

A=Track; B=Moulding machines; C=Core-making machines; D=Core bench; E=Overhead runway; F=Drying stoves; G=Core racks; H=Shaker and revivifier; J=Jib cranes; K=Inclined shoot; L=Sand elevator and damper; M=Blowers; N=Cupolas; O=Charging machine; P=Tipping table; R=Ladle runway; S=Sand storage; T=Sand mills; U=Sand mixers; V=Hoppers over moulders; W=Crane with grab bucket; X=Belt conveyor for castings.

IN THE COURSE of a paper on "The Examination of Defective Ferrous Materials in an Engineering Works," read before the Birmingham Metallurgical Society, on March 1, Mr. T. HENRY TURNER, M.Sc., the author, described the examination of iron and steel castings and of the large forgings used for turbine wheels and shafts, turbo-generator rotors, and similar purposes, remarking that any unusual marking noticed on the surface of the metal during machining must be reported by the foreman or inspector and examined by the metallurgical staff. In this respect the importance of sulphur printing could not be overestimated. Slag spots should be scraped out, firstly because a smooth depression was less liable to cause a fracture than was an irregular slag inclusion, and secondly, to see how serious they were. The possibility of satisfactorily repairing defective castings or forgings was doubted. Welding only produced material comparable with castings. Describing some of the laboratory work entailed by the discovery of such defects, the author said that the microscope and the Brinell and Izod tests were capable of giving all the information required in most cases. The use of micro-projection in a dark room was strongly recommended, for by this means a number of people could examine the structure of the material at the same time, and could point out to one another features of importance in a manner quite impossible in the ordinary laboratory use of a microscope.

Chemical Symbols as an Aid to Foundry Progress.

By F. C. Edwards.

Real progress in any industry must ever depend upon the extent to which scientific knowledge is *consciously* utilised by the practical man in solving his everyday problems. This is generally accomplished in three stages. Except in those cases which may be attributed to pure accident—a by no means negligible quantity in the history of industrial development—improvements mostly originate in the minds of those comparatively rare individuals with rich powers of imagination finely attuned to the needs of some particular industry. The discovery of the basic process of steel manufacture by Sidney Gilcrist Thomas is a case in point. Then follows the experimental stage, in which the chaff is winnowed from the corn, so to speak, and concrete results obtained. Finally, these results are handed over to the rank and file of the industry, by whom they are used with varying degrees of success. Where the improvement lies in the correct application of some established scientific principle, this variation is particularly noticeable.

The use of scientific terms no doubt conduces very largely to this state of things. The practical man—the backbone of any industry—invariably errs on the side of conservatism. His natural aversion to change is not lessened when he reads in his technical Press articles which are intended to enlighten him and to point the way for improvement in his methods, but which contain (to him) vague and unmeaning terms. Frequently, however, the barrier between ignorance and a working knowledge of these terms is more fancied than real: it has only to be tackled to disappear.

Chemical symbols, as used in the foundry, furnish a good illustration of the point. The employment of these very useful and harmless creatures to simplify, say, an explanation of some chemical action frequently produces, on the mind of the practical foundryman, a diametrically opposite result to that intended. He is mystified, and, being unable to follow the explanation, he learns nothing. Or, worse still, he probably becomes a little more sceptical as to the value, to the practical man, of technical articles in general.

Retarding Progress.

Foundry progress undoubtedly has been hindered, and is still handicapped to an incalculable extent, in this way. But this is not the fault of the symbols. They are indispensably necessary for the concise and exact exposition of metallurgical facts. Unfortunately, however, there are many first-class practical foundrymen to whom chemical symbols are as a foreign language. This is the more to be regretted since there exists, in the foundry, probably a greater scope for individual initiative than is to be found in any other industry.

Now, beyond all doubt or question, the very fact that one is a practical foundryman proves, in itself, that he has the mental capacity equal to any situation where chemical symbols are used to explain foundry phenomena. It is merely a question of confidence in his own powers and a little application. What actually is the difficulty? He needs to know (1) what the symbols stand for as individual units; (2) their grouped meaning; and (3) the effect of the mutual interaction of the elements they represent.

Symbols Employed.

Fortunately the symbols in general use in the ironfoundry are few and simple. Iron is represented by Fe (an abbreviation of the Latin word "ferrum"). Carbon, C; silicon, Si; manganese, Mn; sulphur, S; phosphorus, P; oxygen, O; hydrogen, H; and nitrogen, N. There are combinations of some of these in the moulding sand constituents. Silica, SiO_2 (which is the principal constituent, amounting, say, to 90 per cent.). Iron (or to be more precise, ferric) oxide, Fe_2O_3. In addition there is alumina, Al_2O_3; lime (calcium oxide), CaO; limestone (carbonate of lime), $CaCO_3$ magnesia (magnesium oxide), MgO; and the alkalies: Sodium oxide, Na_2O (Na for natrium, the Latin for sodium); and potassium oxide, K_2O (K for kalium, the Latin for potassium).

In non-ferrous work, of course, the use of other elements calls for different symbols. Copper is represented by Cu (from the Latin cuprum); tin, Sn (Latin stannum); zinc, Zn; lead, Pb (Latin plumbum); aluminium, Al; chromium, Cr; nickel, Ni; silver, Ag (Latin, argentum); gold, Au (Latin, aurum); platinum, Pt; antimony, Sb (Latin, stibium).

Grouping of Symbols.

The grouping of these symbols indicate that the elements are in chemical combination. The numerals denote their relative proportions which are required to form this combination. Further, in the combined form, their original physical characteristics, as separate elements, are, in most cases, completely changed. To take a common example, water is a chemical combination of hydrogen (a gas, and the lightest known element) and oxygen (a gas 16 times as heavy as hydrogen), with proportions by volume of 2 and 1 respectively. Using symbols, this combination is represented by the formula H_2O. And the formation of water is expressed by what is called an equation.

Thus:—$H_2 + O = H_2O$ ... ... (i)

or 2 parts of hydrogen combine with 1 part of oxygen to form water. Similarly with all chemical symbols; they merely represent elements or combinations of elements. And equations are simply graphic and concise statements of chemical action, usually in one line, which would otherwise require, say, a paragraph to explain.

Equations.

This leads to the third consideration—the effect of the various elements upon each other. Here, again, generally speaking, the facts are fairly simple. Oxygen, for instance, combines with the other elements, but it manifests a greater preference (affinity it is called) for some than for others; its action is selective. In the presence, say, of carbon and molten iron, its activities are solely confined to the carbon; it leaves the iron alone. Advantage is taken of this fact by the moulder when he applies a coat of blacking, the principal ingredient of which is (or should be) carbon, to the face of his mould. As the molten metal comes into contact with the carbon in the blacking, in the presence of oxygen (from the air in the mould), combustion takes place. This means that the oxygen has been taken up by the carbon. At the same time a gas is produced known as carbon dioxide (CO_2).

The formation of this compound may be represented by the equation:

$C + O_2 = CO_2$ ... ... (ii)

or 1 part of carbon combines with 2 parts of oxygen to form carbon dioxide. Here the important point to keep in mind is, *that the sole function of the carbon is to nullify the potential evil influence of the oxygen when in the presence of molten iron in contact with sand* (or, to be more exact, silica—SiO_2). This it accomplishes by combining with it, as shown in the above equation. Where the carbon is not present, as in the case of an unblacked green-sand mould, the oxygen attacks the surface of the molten iron, and a film of ferrous oxide (FeO) is formed. As before, this may be indicated by an equation:

$Fe + O = FeO.$ ... ... (iii)

or iron plus oxygen equals ferrous oxide.

Now, one of the best-known facts in metallurgy is that the melting point of certain elements and compounds, when brought into mutual contact, is considerably lower than when they are melted separately. Here we have a good illustration. Ferrous oxide (FeO) and silica (SiO_2) form a combination whose melting point is below that of cast iron. This combination is known as ferrous silicate ($2FeO.SiO_2$). And the manner of its formation may be shown by an equation:—

$2FeO + SiO_2 = 2FeO.SiO_2$ ... ... (iv)

2 parts of ferrous oxide combine with 1 part of silica to form ferrous silicate.

Practical Application.

With the formation of this fusible slag on the surface of the mould, the skin of the casting is bound to be far removed from that nice smooth condition which is one of the hall-marks of good founding. Incidentally, the above example makes

clear the reason why an oil-sand core gives a better surface to the casting than an ordinary dry sand core, even if the latter is blacked. For the blacking is but skin deep (and may peel off). Whereas with the oil-sand core—since the whole body of the core is permeated through and through with linseed or similar vegetable oils abounding in carbon-rich material with a ravenous appetite for oxygen—the basic requirements is continuously forthcoming: the power to absorb oxygen. For the same reason it shows that for blacking to be really efficacious it should contain a high percentage of carbon. Furthermore, it proves that with oil-sand cores blacking is altogether superfluous: it is carrying coals to Newcastle.

These practical deductions naturally suggest themselves from a clear grasp of examples such as the one given above. Moreover, they conclusively show how essential it is—both in his own interest and that of the industry in general—that the practical foundryman should become familiar with the meaning of chemical symbols. By doing so he may perhaps realise that some of his pet methods are not quite in accord with proved scientific fact; he will be better equipped to go forward on his own account; and he will unquestionably be a welcome addition to the ranks of investigators in an industry where undoubtedly there is much need for investigation, for the ground has as yet been only scratched.

The British Chemical Standards Movement.

At a meeting of the above, held at York on February 9, a "Report on the Second Three Years' Working" was read, and details of the work during this period were given. A list was given of 53 analysts who had taken part in the standardisation, and 20 firms who had provided material. Ten new samples comprising 46 actual standards were described. Reference was made to the outstanding events since the commencement, and a chronological list of standards, including the total weights standardised, was shown, and copies of 32 certificates issued (from the earliest onwards). British, French, and Italian price lists, and diagrams illustrating the preparation of the standards, were exhibited. The extreme precautions taken to ensure perfect homogeneity were described, and (in answer to a question) the absence of any allegation as to, or evidence of, lack of homogeneity of the standards was elicited. In view of their very wide adoption, however, every means was used to meet even theoretical difficulties, and to warrant the confidence of users.

A sample of shavings of the latest standard "C," cut with a traverse of only $\frac{1}{1700}$th to $\frac{1}{2500}$th in., was shown, which illustrated their extreme thinness and suitability for direct combustion carbon determination. A single portion of usual weight averaged 1,700 pieces with 90 sq. in. superficial area

Reviewing the position, within six years the Movement had steadily developed and become consolidated, maintaining its progress, in spite of the many adverse conditions of recent years. Commencing with a few co-operators in three or four localities in Great Britain, both their number and the range of interests represented had multiplied many times, and now included members from several countries, some 15 to 20 co-operators taking part in each standardisation. The 23 samples produced, comprising 83 standardised results, had covered practically the whole range of plain carbon steels in regular use, and included four alloy steels as well as two cast irons and a basic slag. The weight per standard had risen to 20 or 25 times as great as formerly, and hence the available duration, permanency, and value for reference had increased proportionately; yet the quality, homogeneity, and fine state of turnings, etc., had not merely been maintained, but improved. Now, not only most of the large works' laboratories and many public ones in this country used these standards, but their use had so spread that sole agents had been appointed in Italy and France. The 450 British and foreign users included 10 Government Departments, 30 Universities and Technical Schools, and five railways.

Financially, though there was still considerable deficit, the situation was improving, and the movement gradually progressing towards being self-supporting, without monetary aid from Government or other external source.

The organisation not being restricted to any one society, country or industry, had a world-wide choice of co-operators, and was not dependent on the same group acting over and over again for types of standards for which it might not be fitted, but for each type, co-operators recognised as specialists in that class of analysis, and with large experience of it, were selected.

Their work had demonstrated that:—

(1) In analysis divergencies occurred to an unrealised degree on every sample tested, even under the most favourable conditions of homogeneity and careful working.

(2) Jointly standardised samples were a necessity to reveal these divergencies, and clear them up.

(3) The rapid development of their movement, and consequent creation of such standardised samples for certain types of material, was the surest way to analytical co-ordination, which desideratum not only vitally affected the value and status of chemists, but gave the maker a definite gauge by which to attune his manufacture, secure for the engineer or user closer adherence to specification, and save many delays in delivery, and disputes which now occurred.

(4) Their organisation provided practical working machinery for the production and distribution of standards, and they were justified in believing that the same methods used for iron and steel standards could be applied with equal efficiency to other materials.

Catalogues Received.

THE UNIVERSAL SYSTEM OF MACHINE MOULDING AND MACHINERY COMPANY, LIMITED, 97, Queen Victoria Street, London, E.C.4. A catalogue describing the manufactures of Messrs. the Ph. Bonvillain and E. Ronceray Company, of Paris. This catalogue is distinctly interesting for all foundrymen, as it is full of technical information. The scheme employed has been to deal successively with pattern plates, stripping plates, the cliché system, match plates, and moulding machines. This last section is divided into the hand lever, power, hydraulic, roll-over and electro-hydraulic jar types of machines. Following this comes an interesting section devoted to hydraulic power. Sand-mixing plant is then dealt with, the section being illustrated by machines used for this purpose on the Continent. The balance of the book is made up of descriptions of various plant which goes to complete the equipment of a modern foundry. Amongst these we note the syphon cupola, pig-breakers, core stoves, white metal, rubber sprues, ladles, and the smaller accessories. We would suggest that in future editions an index be incorporated.

Messrs. The British Aluminium Company, Limited, 109, Queen Victoria Street, London, E.C.4.—"Aluminium Facts and Figures" (price 5s.). Whilst we have classified this as a catalogue, because it is published by a manufacturing concern, it contains no advertising matter. It is very adequately described in its title, and it contains no less than 66 pages of data on aluminium and its alloys. It is of pocket size and of the loose-leaf type, so that when the dozen or so blank pages for notes are completed more pages can be added. The contraction of aluminium is given as 1 in 64, but according to Mr. E. H. Tyson the figure is more nearly 1 in 80. As a pocket reference book for a person handling aluminium it will be found invaluable.

Messrs. The Staveley Coal and Iron Company, Limited.—Monthly stock of cast-iron pipes for March.

Briquetting Cast-Iron Borings.

Every user of non-ferrous metals appreciates the economies resulting from the conversion of swarf and borings into briquette form before remelting. But the value of the process for dealing with cast-iron borings is not so generally appreciated, mainly because it would only be in the largest works where the make of such borings would justify the capital outlay for the necessary plant. It still remains for someone to evolve a simple and inexpensive means of converting small quantities of cast-iron borings, etc., into a more or less solid mass.

On a recent visit to the works of Messrs. Wm. Johnson & Sons (Leeds), Limited, Armley Road, Leeds, our representative had an opportunity of inspecting a press which has been built to the order of a firm of textile machinists for briquetting the iron borings made in their Accrington works, where the manufacturing processes result in the production of approximately 50 tons of cast-iron borings per week.

The machine, known as the "President," is designed for mechanical operation, and by the adoption of the toggle lever with knuckle joints can be made to exert a pressure up to 300 tons, though as a matter of fact the working load is 250 tons, and as the machine is designed for the production of a briquette 3 in. in diameter, equal to an area under pressure of 7 sq. in., the pressure is equal to 35 tons on the square inch.

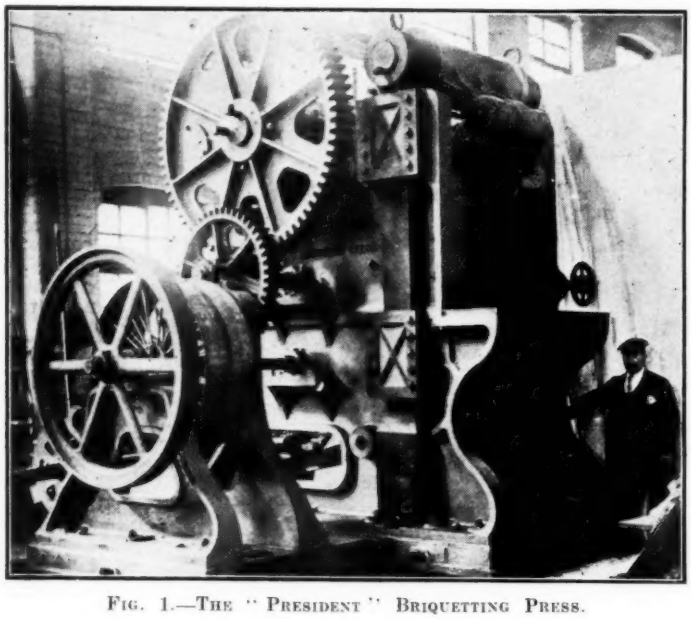


FIG. 1.—THE "PRESIDENT" BRIQUETTING PRESS.

The borings to be briquetted are made slightly damp, and are then fed through a bell-mouthed shute into the feed hopper on the press. The charger is operated by means of a cam through a rocking lever and link, and can be adjusted so as to give the requisite strokes from underneath the hopper to a position above the mould, which is stationary. A stationary mould is adopted because it allows the mechanism to be simplified and reduces wear to a minimum, as also the power required for driving. The charger sweeps the top of the mould when the bottom plungers are in their lowest position, deposits the swarf in the mould, and carries back any surplus on its return stroke. A hand wheel is provided, through which the depth of the mould for filling purposes can be adjusted whilst the machine is running. When the charger has returned to its position beneath the feed hopper the toggle levers commence to expand, being operated by a connecting rod and crank pin through counter gearing. The top plunger then enters the mould and compresses the material at the top. When sufficient resistance is met with, and before the toggle levers assume the perpendicular, the top portion of the levers rise. This is connected by a round steel bar to cast-steel links at each side of the framework, and thence to the bottom pressure block, which, being raised, converts the stationary resistance to a live pressure, and, acting through the blocks and plungers, gives an exactly equal pressure alike to the top and bottom of the material. This takes place when the toggle levers are perpendicular and thus exerting their greatest pressure; they are then carried slightly beyond this position to momentarily relieve the pressure and allow of the escape of any air which may be in the mould, the final pressure being effected on the return stroke, so that two distinct pressures are given at the top and bottom of each briquette. As the toggle levers recede, lifting cams come into operation, which, acting through levers and links, cause the lower block to ascend and so discharge the briquette, which is pushed to the front of the machine as the charger comes forward to commence the next cycle of operations. In the earlier designs of machines protection against injury was afforded by the application of a shearing plate in the top press head, through which a hole would be punched before the round steel connecting bar would shear, in the untoward event of any solid material getting to the mould. This was ingenious, and answered very well in the early days of the press being on duty, though obviously with constant stressing the time came all the sooner when the plate was pierced even before the normal working load was applied.

This trouble has been overcome in the press under notice in a novel way. The bottom plunger is now carried on the head of a hydraulic ram which works in an oil-filled cylinder fitted with a special valve, for which patent rights have been acquired by Messrs. Johnson. Referring to Fig. 2, it will be seen that the cylinder is in two parts, *i.e.*, a compression chamber A and a reservoir chamber B. In the dividing wall between these two chambers are fixed two valves, one being the over-pressure relief valve and the other the return valve. Both valves are adjustable by means of nuts. The action is as follows: The relief valve is adjustable to be immovable up to the ultimate economical working pressure of the press. The return valve is adjusted to just carry the weight of the suction valve itself so that the slightest tendency to vacuum in chamber A causes it to open. Chamber B is filled with water or oil, and this is allowed to flow by pressing the return valve into chamber A and the connecting pipe to the hydraulic cylinder in the main pressure beam of the press, until this cylinder and A are completely filled and chamber B is about one-

third full. Air is therefore excluded. During the working of the press, so long as the economical maximum is not required, no action of the valves takes place, the compressing medium acting as a dead plate. If, however, by any means over-pressure takes place, the relief valve lifts and allows the liquid to flow into chamber B until the pressure is relieved. On the return stroke of the press, the ram in the hydraulic cylinder in the bottom beam of the press returns, carrying with it the liquid, and tends to cause a vacuum in chamber A. Immediately this happens the relief valve closes and the return valve opens, filling chamber A and thus restoring the *status quo*. The machine is designed to make 10 strokes per minute, and requires from 10 to 15 b.h.p. for its operation.

It will no doubt be interesting if we consider the commercial side of this particular plant which, with the kind assistance of Messrs. Wm. Johnson & Sons, we are able to do. For the purpose of

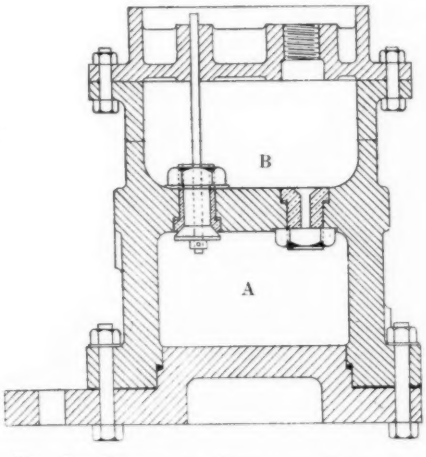


FIG. 2.—SECTION OF HYDRAULIC CYLINDER.

arriving at the approximate results, it is assumed that the plant will be working 50 weeks of 47 hours each and making approximately 15 cwts. of blocks per hour, or 1,762 tons per annum.

Outlay.—Under this heading we have not included for any building, as the plant itself only requires about 100 sq. ft., and we have assumed that sufficient area can be placed at the disposal of the plant. If a building is required this should be added to the outlay cost.

	£
Elevator, mixer and press	1,700
Motor to drive (15 h.p.)	100
4 flat-top wagons and 60 ft. of rail	30
Pulleys and belts	60
Cost of foundation and erection ...	55
	£1,945
	Say £2,000

Labour Required to Manufacture :—

	Per ton.
1 Lad feeding elevator at 6d. per hour	= 8d.
1 Lad taking off at 6d. per hour	= 8d.
1 Lad wheeling off at 6d. per hour	= 8d.
Total labour	= 2s. 0d.

Materials.—Present price of borings 15s. per ton.

Working expenses :—

	Per ton. s.	d.
Interest on capital of £2,000 at 7 per cent.	= 1	7
Depreciation at 5 per cent.	= 1	2
Repairs	= 1	1
Labour	= 2	0
Oil and sundries	= 0	3
Power (electric) at 1¾d. per unit, or 1½d. per h.p.	= 1	10½
Cost of borings	= 15	0
Total cost of manufacture	= £1 2	11½
	Say £1 3	0

Profit and Loss.—Value of scrap to-day is between £2 5s. and £4 10s. per ton. Take the value of blocks as between these amounts, say £2 10s. per ton.

By sales of 1,762 tons at £2 10s. per ton =	£4,405
To cost of manufacture at 23s. per ton ... =	2,202
Profit ..... =	£2,203

The values of borings and scrap iron differ of course from day to day, as also their values relative to each other in different districts; our calculations are, however, based upon the figures ruling at the time this article is written.

German Iron and Steel Industry.

The iron and steel industry in Germany complains of bad times, and estimates production for 1922 at 6,500,000 tons of pig-iron and 9,000,000 tons of steel, as against 19,000,000 and 18,631,000 tons in 1913 respectively. Other data in this connection, and especially that of foreign trade, show that whilst the exports of iron and steel in 1913 totalled 6,502,800 tons, in 1922 these amounted to some 2,654,000 tons only, whilst the imports are officially given as 619,000 and 2,500,000 tons respectively. Of these totals the items representing pig-iron are:—

	1913. Tons.	1922. Tons.
Exports	782,910	158,000
Imports	124,316	294,000

By a special decree of the German Government, the publication of statistics dealing with output in the Ruhr district is now prohibited, but it is obvious that since the beginning of the French invasion pig-iron and steel production in Germany has decreased. Certain authorities interviewed on the subject estimate the decrease at between 30 and 70 per cent. These figures appear excessive, but they cannot be checked.

The fluctuations in pig-iron prices calculated in gold marks are also of interest. The average price in 1913 in Germany was 74.50 marks per metric ton, whilst those in France, England, and the United States, calculated in marks, were 71.00, 71.59, and 61.75 marks respectively. The German prices in 1922 on the gold basis were (in marks per ton): January, 71.48; April, 80.14; July, 67.58; October, 48.43; December, 90.55. In January, 1923, the price rose to 93.37 gold marks, and since that date it has been frequently readjusted in paper marks. The rise in the prices of iron and steel products is even greater than the corresponding rise in their raw material, but is of course subject to the risk of further currency depreciation.

Of all the German industries, the iron and steel industry is perhaps in the most favourable position as regards supplies. Iron ore is coming in both from Spain and Sweden, where big contracts were made in the second half of 1922, when the mark stood at 60 per cent. above its present rate of exchange. The industry as a whole is well supplied with foreign currency, both at home and in banks abroad. The question of rising wages, when closely examined, shows that in spite of increases granted by the employers to the workers, the rises in the prices of iron and steel, which are periodically adjusted, leave a good margin in favour of the former.

Baldwin Locomotive Works Earnings.—Earnings of the Baldwin Locomotive Works declined last year to $1,994,361 from $8,112,694 in 1921. Gross sales of $33,087,258 were reported compared with $49,945,506 in 1921. The Company received considerable revenue from dividends distributed by the Standard Steel Works, which it controls. The balance-sheet at the close of 1922 showed net cash profits of $5,206,519 ($5,044,096 in 1921), preferred dividends of $1,400,000 and common dividends of $1,400,000 (both as in 1921). The surplus at the end of the year totalled $2,406,519, as against $2,244,096 at the end of 1921.

Swan, Hunter & Wigham-Richardson, Limited, have acquired the North British Diesel Engine Works, Whiteinch, Glasgow, with a view to extending the output of Diesel engines for marine and land service. The company have made an arrangement with the engineering company of John G. Kincaid & Company, Limited, Greenock, whereby an exchange of shares has been effected. They have also acquired an interest in the New York Harbour Dry Dock Company, Inc., whose works and floating docks of 12,000 and 8,000 tons lifting capacity are situated at Clifton, Staten Island, in New York Harbour.

XUM

Trade Talk.

THE HELIOS STEEL & DRILL COMPANY have removed from 39, Norfolk Street, to 124, Pond Street, Sheffield.

THE UNITED STEEL COMPANIES resumed operations at their Moss Bay steelworks at Workington on Monday morning.

BARIMAR, LIMITED, have moved to larger premises at 14/18, Lamb's Conduit Street, Theobalds Road, London, W.C.1.

LICENCES under the Non-Ferrous Metal Industries Act (1918) have been granted to Lloyd, Bateman & Company, London; and H. G. Sommerfield, London.

R. WHITE & SONS, John Hargreaves (Bacup), Limited, Rowarth Atkins Steel Works Company, and Joseph Crawhall & Sons have joined the Federation of British Industries.

DRAKE & GORHAM, LIMITED, of 36, Grosvenor Gardens, London, S.W.1, have been appointed agents in Great Britain and Ireland for the Electric Furnace Construction Company, of Philadelphia, U.S.A.

THE DIRECTORS of W. H. Dorman & Company, Limited, are prepared to receive applications from holders of the 8 per cent. 7-year notes for the surrender of notes for cancellation in part satisfaction of the price of second debenture stock at par.

MR. J. H. SCOTT, for many years with William McGeoch & Company, Limited, of Glasgow, has established himself in business at 198A, St. Vincent Street, Glasgow, and has been appointed agent in Scotland for Drake & Gorham (Wholesale), Limited.

THE ENGLISH ELECTRIC COMPANY, LIMITED, have recently obtained an order for a reversing electrical drive for the 30-in. finishing rail mill at Guest, Keen & Nettlefolds' Dowlais Works. The mill motor will be capable of giving a maximum power of 8,600 h.p. at a speed of 60 to 120 r.p.m.

AT THE meeting of the Institution of Mechanical Engineers, on Friday, March 16, the second report of the Steam-Nozzles Research Committee will be presented. The London Graduates Section meets on the following Monday, when Mr. R. C. Bond will speak on the Walscharert Locomotive Valve-Gear.

THE COSMOS ENGINEERING WORKS, Fishponds, Bristol, have been acquired by Parnall & Sons, Limited. The property was erected several years ago by Brazil, Straker & Company, Limited, and subsequently acquired by the Cosmos Engineering Company. The works cover an area of over five acres, the floor space of the buildings being approximately 20,000 square yards.

THE MIRRLEES WATSON COMPANY, LIMITED, have an order for a new 15,000-kilowatt turbo-generator for the Underground Railway. This will bring the generating equipment of the power-house at Lots Road up to 8 turbo-generators of 6,000 kw. and 3 turbo-generators of 15,000 kw., making a total capacity of 93,000 kw. for supplying power for the Underground Railways.

CLYDE SHIPBUILDERS launched five vessels of 18,846 tons last month, as compared with four vessels of 15,695 tons in February of last year. For the two months the total consists of nine vessels of 34,541 tons, as compared with 17 vessels of 79,212 tons last year, and 32 vessels of 93,431 tons in the first two months of 1921, which had the highest figures on record for the period.

THE RAILWAY MANAGERS at the Railway Clearing House, on Tuesday, considered the question of an immediate reduction in the present goods rates. A deputation from the Federation of British Industries urged the necessity for prompt action, but the managers, over whom Sir Herbert Walker presided, were unable to arrive at any decision, and adjourned further discussion to a subsequent meeting.

SOME INTERESTING QUESTIONS were discussed at the annual dinner of the Refractories Association, held at Sheffield on March 2. Mr. H. J. C. Johnston, of Leeds (president of the Institute of Clay Workers), said to the refractory industries as a whole the fact of having a national regularisation of wages during the war was a very great boon indeed. Without such an arrangement, much higher wages would have had to be paid in many parts of the country. It was now a matter of good faith with the other side that they should not turn down the national system. Another important question which they had in hand was that of railway rates. He acknowledged the valuable assistance which the other associations had had from the Refractories Association in their negotiations with the railway companies. They were sorry that they had not been more successful, and, above all, he was sorry that their industry had met with so little support from the Federation of British Industries. They were entitled to ask that a greater reduction should be given to heavy trades like theirs than to those which dealt with dry goods, as their traffic called for much less handling.

Company News.

Ibbotson Brothers & Company, Limited.—No interim dividend will be paid.

Vulcan Foundry, Limited.—Interim dividends 6d. per share on preference and 1s. per share on ordinary, both less tax.

Albert Harvey & Company, Limited, 5, Tooks Court, London, E.C.—Capital £1,000. General engineers. Permanent directors: F. Burgess, A. C. W. Cranko and A. Harvey.

Adam, Small & Company, Limited, 298, Maxwell Road, Pollokshields, Glasgow.—Capital £2,000. General engineers, etc. Directors: M. W. Montgomery, A. W. Montgomery and W. M. Gordon, junr.

North British Locomotive Company, Limited.—Profit, £35,751; brought forward, £204,741; preference dividend, £37,500; ordinary dividend, 7½ per cent., free of tax, for year; carry forward, £109,242.

Beyer, Peacock & Company, Limited.—Profit, £16,403; depreciation, £16,986; brought forward, £7,711; transfer £10,000 from general reserve; dividend on ordinary for year, 5 per cent. less tax; carried forward, £2,615.

Allen Cleaver & Company, Limited, 1, East India Avenue, London, E.C.—Capital £1,500, in £1 shares (150 6½ per cent. cumulative preference and 1,350 ordinary). Metal merchants, etc. Directors: A. Cleaver and A. Peacock.

Engineers & Ironfounders, Limited.—Revenue £5,290; brought forward, £7,472; dividend, 7 per cent. cumulative preference shares; interim dividend on ordinary, 1s. per share; final dividend, 7 per cent. on cumulative preference; final ordinary dividend, 1s. per share; carried forward, £9,779.

Bruce Peebles & Company, Limited.—Preference dividend, 7½ per cent. per annum, less tax, for half-year ended December 31, 1922, and further 2½ per cent. per annum, less tax, for year ended December 31, 1922; ordinary dividend for year, 10 per cent. per annum, less tax, together with bonus 5 per cent., less tax.

Davis & Timmins, Limited.—Brought forward, £17,740; recovered in respect of E.P.D. and adjustment of income-tax, £23,971; net profit, £12,869; reserve, £4,000; income-tax account, £4,540; interim dividend on preference, £1,800; interim dividend on ordinary, 6 per cent. per annum, £1,410; final dividend on preference, 6 per cent. per annum, £18,000; balance dividend, 10 per cent. per annum on ordinary, making 8 per cent. for year (free of tax), £2,350; bonus, 17 per cent. (free of tax), £7,990; carried forward, £30,682.

Swan, Hunter & Wigham-Richardson, Limited.—Net profit, £411,277; brought forward, £53,263; interest on 4½ per cent. first mortgage debenture stock for year, £13,742; instalment for sinking fund account, £1,000; interim dividend, 3 per cent. on cumulative preference shares, £22,195; ditto, 3 per cent. on ordinary, free of tax, £51,332; further dividend, 3 per cent. on cumulative preference shares, making 6 per cent. for year, £23,695; ditto, 5 per cent. on ordinary, free of tax, making 8 per cent. for year, free of tax, £85,553; reserve, £150,000; reserve for equalisation of dividends, £50,000; benefit of employés, £10,000; carried forward, £57,023.

Personal.

MR. S. A. PUTNAM, secretary of John Lysaght, Limited, has been elected to a seat on the board of that company.

MR. H. N. GRESLEY has been appointed chief mechanical engineer to the London & North-Eastern Railway Company.

MR. H. C. BOND, J.P., managing director of Richard Thomas & Company, Limited, has been injured in a motor collision.

MR. FRANK P. HANN, the general manager, has been elected to a seat on the board of the Ebbw Vale Steel, Iron & Coal Company, Limited.

THE LATE MR. W. M. WARDLOW, of S. & C. Wardlow, Portobello Steel Works, Sheffield, and Congress Works, Oughtibridge, left £72,332.

MR. F. W. GILBERTSON has been the recipient of a presentation from the members of the South Wales Siemens Steel Association, in appreciation of his services as president.

MR. F. PHILLIPS, joint managing director of the Park Gate Iron and Steel Company, Limited, of Rotherham, has been elected president of the local Chamber of Commerce.

MR. ALEXANDER WALLACE, of Edinburgh, has been elected chairman of the Shotts Iron Company, Limited, and Mr. Matthew Brown, the general manager, has been elected managing director.

Telephone: 21, Penistone. Telegrams: "Durranns, Penistone."

ESTABLISHED 1863.

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IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—The position in the Cleveland market continues uncertain and extremely difficult to estimate from week to week, and although at the moment values are practically stationary at previous high levels, it is by no means certain that the upward tendency has reached its limit. Demand, meanwhile, is on an undiminished scale, while on the other hand smelters are virtually booked up until May, a date beyond which operators are reluctant to undertake further commitments pending a much more definite prospect of market stability. The inquiry from abroad is also on a heavier scale, both France and Belgium being in the market for substantial tonnages, consequent, it is assumed, on failure of supplies from the Ruhr area. With fuel costs still on the up grade, ironmasters are experiencing difficulty in putting more furnaces into blast, and there is therefore fair prospect of obtaining fuller supplies of pig to meet the increasing demand. Recent offers of American iron to Italy have been reported, but it would now seem that a real shortage is imminent in the States, and Italian inquiries, at all events for hematite, are coming to Cleveland. The American incursion would thus seem to have been no more than a demonstration.

As regards East Coast hematite, it is difficult at present to quote a figure for prompt delivery, for there is practically none of this quality of iron to be had. May is about the earliest delivery obtainable, and some makers are quoting only to June, but no one is in the least keen. There is a heavy volume of export business being booked, but makers are conserving prospective outputs in the interests of their home customers. Three more furnaces have been re-started on hematite, but this has had no real effect upon the position, the demand still being much in excess of output. Germany was a heavy buyer last month, and is still prominently in the market.

MANCHESTER.—The situation as regards pig-iron market movements in the Lancashire area is somewhat exceptional, the actual demand being less than was reported earlier in the year, while business is on a more restricted scale. The explanation is, however, simple enough, many consumers having bought at the earlier period to cover requirements over the first three months on fairly favourable terms, and in a few instances even more distant dates, and are thus in a position to withhold buying orders in expectation of lower prices.

THE MIDLANDS.—Business in the South Staffordshire iron market shows little improvement, supplies of pig available for immediate delivery being practically negligible, while any movement on the part of smelters towards increasing outputs is negatived by the impossible prices now quoted for fuel. In such conditions quotations are virutally nominal, and in the case of buyers for prompt iron to meet urgent needs much enhanced prices have to be paid. Some consumers also are complaining of the difficulty of obtaining supplies under current contracts, delays frequently arising from causes entirely outside smelters' control. There are very few forward transactions recorded or possible at present, makers declining to consider future contracts while the position remains so uncertain and unsatisfactory.

SCOTLAND.—Movements in the Glasgow pig-iron market indicate unabated strength, with prices again advanced. The demand is chiefly for shipment, the Continent calling for supplies of both hematite and foundry. This demand for Scotch iron is accentuated by the high price being asked for No. 3 Middlesbrough.

Finished Iron.

Reports from the chief centres of manufacturing industry confirm the impression of a favourable turn in the conditions of the finishing branches of the trade, with a satisfactory decrease in the numbers of the unemployed in the various branches. The engineering industry in the Midlands is, for example, steadily expanding, while the bar mills and forges are better employed. The quotation for marked bars has undergone no alteration, but other qualities become dearer from week to week.

Steel.

Continued expansion is marked in the steel industry, the most recent development being a largely increased demand for railway material in the form of axles, tyres, springs and rails, orders for which are in course of completion for most of the British and overseas companies. At Sheffield the Siemens-Martin furnaces operating on mild steel are working almost at full capacity, while a leading firm have eighteen out of twenty-six furnaces in work, and as it is necessary to have some standing by for a change over this is gratifying. Bessemers are reported to have three-and-a-half times more orders than a year ago. Manufacturers of semi-products also report an active demand for billets, for which prices have further advanced.

Scrap.

With the rapidly advancing prices of pig-iron consumers are devoting more attention to scrap material, and most markets for the latter now report an active demand. In the Tees-side district heavy steel scrap still remains at a relatively low figure, works only paying about 85s. But sellers are not inclined to do much at this price. Heavy cast-iron scrap is very strong at 100s. for good machinery quality, ordinary descriptions being about 92s. 6d. Heavy steel turnings are now fully 67s. 6d., but c.i. borings can still be done round about 65s.

Metals.

Copper.—Optimistic views of the position continue unchecked in the market for standard copper, and although values reacted to a slight extent at the week-end, due to speculative realisation, the undertone is still strong and buoyant. The market generally, it is believed, is being manipulated by American interests in connection with Wall Street operations. No figures are available respecting production; thus consumers have to rely on trade reports. The warrant market on this side is principally supported by operators with American connections, and all sorts of people are interested in paper copper. It is estimated that something like 85,000 tons were sold during last month. Stocks in the U.K. are given as 27,632 tons; in the States reports tell of greatly reduced stocks, but of course some allowance must be made for the bullish enthusiasm prevailing in the States for all commodity prices. Current quotations :—*Cash* : Wednesday, £71 7s. 6d.; Thursday, £72 7s. 6d.; Friday, £72 7s. 6d.; Monday, £72 12s. 6d.; Tuesday, £72 10s. *Three Months* : Wednesday, £72 2s. 6d.; Thursday, £72 2s. 6d.; Friday, £73 5s.; Monday, £73 2s. 6d.; Tuesday, £73 2s. 6d.

Tin.—The market for standard tin during the past week has disclosed renewed activity in demand, while values, already at inflated levels, have further appreciated, achieving a record figure at the close. Dealings in the metal were on a considerably enlarged scale, American interests being very active. Another sharp advance was reported at Singapore, where a new high record for the present movement was established with a figure of £233 per ton. Higher prices continue to be predicted with confidence, but there is always the possibility of at least a temporary reaction, and the existence of important speculative commitments must not be lost sight of. Straits tin is in limited supply, and commands a premium of about £8 per ton over standard metal. Current quotations :—*Cash* : Wednesday, £212 10s.; Thursday, £213 15s.; Friday, £217 5s.; Monday, £224 10s.; Tuesday, £234 5s. *Three Months* : Wednesday, £213 10s.; Thursday, £214 10s.; Friday, £217 15s.; Monday, £224 10s.; Tuesday, £234 10s.

Spelter.—Values of spelter are fairly firmly maintained on the strength of a favourable statistical return, and a good business is passing. Messrs. Rudolf Wolff & Company report that a good deal of the strength of the metal has been influenced by strong reports and rising prices which have been advised from America, and furthermore in sympathy, to some extent, with the strength of the tin and copper markets. The position on the Continent is also firm, and producers there being fairly well sold, adopt a rather independent attitude. Current quotations :—*Ordinary* : Wednesday, £36 12s. 6d.; Thursday, £36 12s. 6d.; Friday, £36 15s.; Monday, £36 7s. 6d.; Tuesday, £36 17s. 6d.

Lead.—Business in the market for soft foreign pig has been comparatively quiet with quotations steady. The undertone, however, is firm, and though the price is high it would seem that unless production is substantially increased, there is no immediate prospect of any material decline. No doubt the high price induces buyers to act with caution, and this in a measure accounts for the comparative quietness of the market. Current quotations :—*Soft foreign (prompt)* : Wednesday, £29 7s. 6d.; Thursday, £29 7s. 6d.; Friday, £29 7s. 6d.; Monday, £29 2s. 6d.; Tuesday, £29.

XUM

Telegrams: "THROWER, GLASGOW." Telephone: 5909 CENTRAL.

ALBERT SMITH & Co FOUNDRY ENGINEERS. TOOLS & EQUIPMENT

Head Office: 60, St. ENOCH SQUARE, GLASGOW.

SAND BLAST EQUIPMENT. For any Service.

MOULDING MACHINES. Electric, Air and Hand Power.

SAND MIXING PLANT. Riddles, Mixers, Elevators, Conveyors for Electric, Pneumatic or Belt Drive.

PORTABLE CORE OVENS.

CORE MACHINES. Core Compound. Core Oil. Glutrin. Parting Powder. Perforated Chaplets, &c.

BRASS RECOVERY MACHINES. New Process.

A money-saving invention evolved by British brains, backed by British Capital, manufactured by British Labour, and used by leading British Founders.

By using
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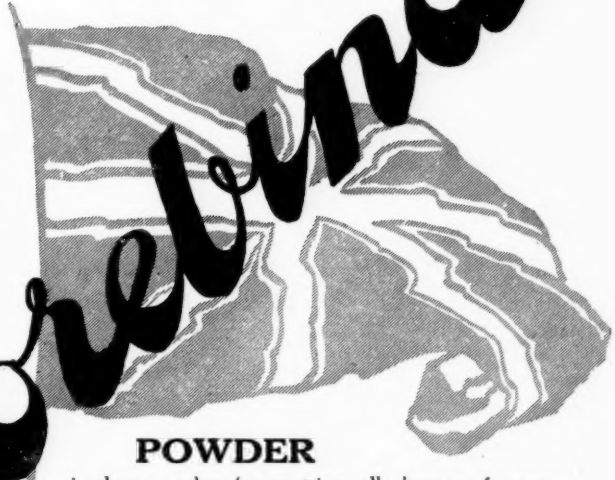
COREBIND halves your Sand bill by renovating old and spent Sand

Numerous testimonials from leading firms prove that COREBIND is indispensable in the Foundry.



POWDER
in three grades, for making all classes of cores.

LIQUID
in three grades, for renovating spent sand, and for Aluminium.

Your rivals know its merits. *A trial will convince you.*

FOR FULL PARTICULARS WRITE:

The Chemical and Technical Engineering Company, Ltd.
FOUNDRY DEPT.
11, Pancras Lane, Queen Victoria Street, London, E.C.4
Telegrams—"Bankolon, London." Telephone—Central 7187.

Works and Research Laboratories:
HILLINGDON HEATH, MIDDLESEX
'Phone—Hayes 56.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	72	10	0
Three months	73	2	6
Electrolytic	80	10	0
Tough	75	10	0
Best selected	75	10	0
Sheets	104	0	0
India	91	10	0
Wire bars	81	0	0
Do. Mar.	81	0	0
Do. Apr.	81	0	0
Ingot bars	81	0	0
H.C. wire rods	86	0	0
Off. aver., cash, Feb.	67	15	3
Do. 3 mths., Feb.	68	9	6
Do. Settlement Feb.	67	15	1½
Do. Electro, Feb.	74	15	4½
Do. B.S., Feb.	72	6	3
Aver. spot price, copper, Feb.	67	14	3
Do. Electro, Feb.	75	0	9

Solid drawn tubes 14½d.
Brazed tubes 14½d.
Wire 11½d.
Yellow metal rods 7½d.
Do. 4x4 Squares 9d.
Do. 4x3 Sheets 10d.

BRASS.

Solid drawn tubes 12⅞d.
Brazed tubes 14d.
Rods, drawn 11½d.
Rods, extruded or rolled 7½d.
Sheets to 10 w.g. 11d.
Wire 11d.
Rolled metal 10½d.

TIN.

Standard cash	234	5	0
Three months	234	10	0
English	235	0	0
Bars	237	0	0
Chinese	235	0	0
Straits	241	15	0
Australian	237	15	0
Eastern	233	0	0
Banca	237	15	0
Off. aver., cash, Feb.	190	12	0¾
Do. 3 mths., Feb.	192	7	5¼
Do. Sttlment, Feb.	190	11	4½
Aver., spot, Feb.	190	10	4½

SPELTER.

Ordinary	36	17	6
Remelted	34	5	0
Hard	29	0	0
Electro 99.9	43	10	0
English	37	10	0
India	31	0	0
Prime Western	37	0	0
Zinc dust	50	0	0
Zinc ashes	14	0	0
Off. aver., Feb.	35	8	9
Aver., spot, Feb.	35	12	2½

LEAD.

Soft foreign ppt	29	0	0
English	30	5	0
Off. average, Feb.	28	6	5¼
Average, spot, Feb.	28	10	4½

ZINC SHEETS, &c.

Zinc sheets, English	43	0	0
Do. V.M. ex whf.	42	0	0
Dutch	42	0	0
Rods	49	0	0
Boiler plates	41	0	0
Battery plates	42	0	0

ANTIMONY.

English regulus	30	10	0
Special brands	36	10	0
Chinese	27	10	0
Crude	20	0	0

QUICKSILVER.

Quicksilver, nominal 12 2 6

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—
45/50% £12 7 6
75% £20 5 0
Ferro-vanadium—
35/40% 17/- lb. va.
Ferro-molybdenum
70/75% c. free 9/6 lb. mo
Ferro-titanium—
23/25%, carbonless 1/1½ lb.
Ferro-phosphorus, 20/23%, £24
Ferro-tungsten—
80/85%, carbon free 1/5 lb.
Tungsten metal powder—
98/99% 1/10½ lb.
Ferro-chrome—
4/6% car. £21 0
6/8% car. £20 10
8/10% car. £20 0
Ferro-chrome—
Max. 2% car. £52 0
Max. 1% car. £62 0
Max. 0.70% car. £72 0
67/70%, carbonless 1/6 lb.
Nickel—99%, cubes or pellets £130 0
Cobalt metal—98/99% 12/- lb.
Aluminium—98/99% £105
Metallic Chromium—
96/98% 4/6 lb.
Ferro-manganese (net)—
76/80%, loose £16
76/80%, packed £17
76/80%, export £16
Metallic manganese—
94/96%, carbonless 2/- lb.
Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten s. d. 2 6
Finished bars, 18% tungsten 3 0
Per lb. net, d/d buyers' works.
Extras—
Rounds and squares 3 in. to 8 in. inclusive 4d. lb.
Rounds and squares under ½ in. to ¾ in. 3d. lb.
Flats under 1 in. by ⅜ in. to ½ in. by ¼ in., and all sizes over four times in width over thickness 3d. lb.
Bevels of approved sizes and sections 6d. lb.
If in coils 3d. lb.
Packing £3 ton.
Bars cut to length 10% extra

Scrap from high-speed tool steel—
Scrap pieces 3d.
Turnings and swarf 1d.
Per lb. net, d/d steel makers' works.

SCRAP.

South Wales—	£	s.	d.	£	s.	d.
Heavy steel	4	10	0	5	0	0
Bundled steel & shearings	4	2	6	4	10	0
Mixed iron & steel	4	3	6	4	7	6
Heavy cast iron	4	3	6	4	5	0
Good machinery for foundries	4	7	6	4	10	0
Cleveland—						
Heavy steel				4	5	0
Steel turnings				3	7	6
Cast-iron borings				3	5	0
Heavy forge				5	0	0
Bushelled scrap				4	7	6
Cast-iron scrap				5	0	0
Lancashire—						
Cast-iron scrap				5	0	0
Heavy wrought				5	0	0
Steel turnings				3	12	6

London — Merchants' buying prices delivered yard.

Copper (clean)	67	0	0
Brass (clean)	39	0	0
Lead (less usual draft)	26	0	0
Tea lead	24	0	0
Zinc	25	0	0
New aluminium cuttings	67	0	0
Braziery copper	57	0	0
Gun metal	52	0	0
Hollow pewter	170	0	0
Shaped black pewter	100	0	0

PIG-IRON.

N. E. Coast—
Foundry No. 1 130/-
Foundry No. 3 125/-
Forge No. 4 120/-
Mottled —
Hematite No. 1 123/6
Hematite M/Nos. 122/6
Midlands—
Staffs. common —
„ part-mine forge —
„ „ foundry —
„ Cold blast, ord. 190/-
„ „ roll iron 200/-
„ basic —
Northants forge 95/-
„ foundry No. 3 105/-
„ basic 100/-
Derbyshire forge 95/-
„ foundry No. 3 105/-
„ basic 100/-
Scotland—
Foundry No. 1 125/-
„ No. 3 120/-
Hematite M/Nos. 117/6
Sheffield (d/d district)—
Derby forge 98/6
„ foundry No. 3 108/6
Lincs. forge 95/-
„ foundry No. 3 100/-
„ basic 120/-
E.C. hematite 132/9
W.C. hematite 130/-
All d/d in the district.
Lancashire (d/d eq. Man.) —
Derby forge —
„ foundry No. 3 115/-
Northants foundry No. 3 —
Cleveland foundry No. 3 —
Staffs. foundry No. 3 —
Lincs. forge —
„ foundry No. 3 —
Dalzell, No. 3 136/7
Summerlee foundry 136/7
Glengarnock foundry 136/7
Gartsherrie foundry 136/7
Monkland foundry 136/7

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.	to	£	s.	d.
Bars (or.)	11	10	to	12	10	0	
Angles				12	5	0	
Tees to 3 united ins.				12	10	0	
Nut and bolt				11	10	0	
Hoops				15	0	0	
Marked bars (Staffs.)				13	10	0	
Gas strip	£11	15	to	12	0	0	
Bolts and nuts, ⅜ in. × 4 in.				18	10	0	
Steel—							
Ship plates				10	0	0	
Boiler plates				14	0	0	
Chequer plates				10	15	0	
Angles	£9	10	0	to	10	0	0
Tees	£10	0	0	to	11	0	0
Channels				10	0	0	
Joists				9	10	0	
Rounds & squares 3 in. to 5½ in.				11	5	0	
Rounds under 3 in. to ⅜ in.				11	0	0	
Flats, over 5 in. wide and up				11	10	0	
Flats, 5 in. to 1½ in.				10	15	0	
Rails, heavy				9	10	0	
Fishplates				13	10	0	
Hoops (Staffs.)				12	0	0	
Black sheets, 24 g.				13	10	0	
Galv. cor. sheets, 24 g.	£19	5	0	to	19	10	0
Galv. fencing wire, 8 g. plain				17	0	0	
Rivets, ¾ in. dia.				13	15	0	
Billets, soft	8	0	0	to	9	10	0
Billets, hard	8	10	0	to	10	5	0
Sheet bars	8	10	0	to	9	0	0
Tin bars				8	16	0	

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1 4
Sheet	1 4¾
Wire	1 4¾
Rods	1 3½
Tubes	1 7
Castings	1 2

Delivery 3 cwt. free to any town.
10% phosphor copper, £40 above price of B.S.
15% phosphor copper, £50 above price of B.S.
Phosphor tin (5%), £30 above price of English ingots.
Charles Clifford & Son, Limited, Birmingham.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/4 to 1/10
To 18 in. wide	1/4½ to 1/10½
To 21 in. wide	1/5½ to 1/11½
To 25 in. wide	1/6½ to 2/0½
Ingots for spoons and forks	9d. to 1/3
Ingots rolled to spoon size	1/- to 1/6
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	30.76
No. 2 foundry, Valley	28.00
No. 2 foundry, Birm.	25.00
Basic	28.96
Bessemer	30.27
Malleable	30.46
Grey forge	29.27
Ferro-manganese 80% delivered	107.50
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y, at mill	43.00
Bess. billets	40.00
O.-h. billets	40.00
O.-h. sheet bars	40.00
Wire rods	50.00
	Cents.
Iron bars, Phila.	2.57
Steel bars	2.25
Tank plates	2.25
Beams, etc.	2.25
Skelp, grooved steel	2.25
Skelp, sheared steel	2.25
Steel hoops	2.90
Sheets, black, No. 28	3.50
Sheets, galv., No. 28	4.60
Sheets, blue an'l'd, 9&10	2.65
Wire nails	2.80
Plain wire	2.65
Barbed wire, galv.	3.45
Tinplate, 100-lb. box	$4.95

COKE (at ovens).

Welsh foundry 40/- to 45/-
„ furnace 30/- to 35/-
Durham & North. fdy. 42/6
„ furnace 33/6
Other Districts, foundry 45/-
„ furnace 35/-

TINPLATES.

f.o.b. Bristol Channel ports.

I.C.Cokes,	20×14, box	23/3
„	28×20, „	46/6
„	20×10, „	32/10½
„	18¾×14, „	23/3
C.W.	20×14, „	21/3
„	28×20, „	42/6
„	20×10, „	29/6
„	18¾×14, „	21/6
Ternes, f.o.t.	28×20, „	43/-

TUBES.

Up to and incl. 6 in.

Gas .. ..57½% } Tube prices
Water ..52½% } are
Steam ..47½% } now free.

SWEDISH IRON.

Bars, hammered basis sizes—Basis price £22 to £23

Rolled Ordinary—Assortment .. } £ s. d.
Nail Rods— } 17 0 0
Square, round and flats .. } to 17 10 0

Keg Steel nom. £38 to £40
Faggot Steel nom. £30 to £32

Blooms—
Single welded .. £10 to £11

Billets—
Single and double welded .. .. £13 to £14

Pig-iron—
Grey, white or mottled £6 10 to £7 5 0

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.		
Mar. 7	72	7	6	dec.	25/-
„ 8	72	7	6	inc.	20/-
„ 9	72	7	6	No change	
„ 12	72	12	6	inc.	5/-
„ 13	72	10	0	dec.	2/6

Electrolytic Copper.

Mar. 7	79	10	0	dec.	10/-
„ 8	80	15	0	inc.	25/-
„ 9	80	10	0	dec.	5/-
„ 12	80	10	0	No change	
„ 13	80	10	0	„	

Standard Tin (cash).

Mar. 7	212	10	0	inc.	15/-
„ 8	213	15	0	„	25/-
„ 9	217	5	0	„	70/-
„ 12	224	10	0	„	145/-
„ 13	234	5	0	„	195/-

Tin (English ingots).

Mar. 7	213	10	0	inc.	20/-
„ 8	214	10	0	„	20/-
„ 9	218	0	0	„	70/-
„ 12	225	10	0	„	150/-
„ 13	235	0	0	„	190/-

Zinc Sheets (English).

Mar. 7	44	0	0	No change	
„ 8	44	0	0	„	
„ 9	43	0	0	dec.	20/-
„ 12	43	0	0	No change	
„ 13	43	0	0	„	

Spelter (ordinary).

Mar. 7	36	12	6	inc.	1/3
„ 8	36	12	6	No change	
„ 9	36	15	0	inc.	2/6
„ 12	36	7	6	dec.	7/6
„ 13	36	17	6	inc.	10/-

Lead (English).

Mar. 7	30	10	0	dec.	5/-
„ 8	30	10	0	No change	
„ 9	30	10	0	„	
„ 12	30	5	0	dec.	5/-
„ 13	30	5	0	No change	

AVERAGE MONTHLY PRICES OF WEST COAST HEMATITE MIXED NUMBERS.

Year.	Jan.	Feb.	March.	April	May	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Yearly Average.
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1885	44 0	44 1	43 2	43 1	42 10	42 6	42 6	42 0	42 2	42 1	43 0	43 8	42 11½
1886	43 3½	42 0	42 0	41 6½	41 2½	40 0	40 0	41 2½	41 6	44 0	44 0	44 9	42 2½
1887	49 6	48 9½	45 6	43 2½	43 6½	44 1	44 0	44 2½	43 5½	41 6	41 9½	45 0	44 6½
1888	44 4	42 3	42 1½	42 0	41 2½	42 1½	42 6½	44 0	45 8½	44 6	44 6	45 3½	43 4
1889	44 4	45 2	47 3½	48 9½	48 6½	48 7½	50 1½	53 11	55 3	63 6	73 10	73 2	54 4½
1890	76 1½	65 1	63 3	55 1	53 9½	50 11	52 3½	56 4	58 0	58 2	57 5	54 4½	58 5
1891	52 9	50 10	48 11	47 9½	51 5	50 6	50 10	48 4	50 1	49 1½	48 3½	47 8	49 8½
1892	47 4	45 6	46 4½	47 8	49 5	50 4½	49 7½	49 10½	49 10½	48 8½	46 10	46 1½	48 2½
1893	46 0½	45 8	45 11	45 7	44 11	44 9½	44 10	45 3	45 0	44 6	44 7	45 8	45 3
1894	45 3	45 3	45 1½	45 1	43 11	43 11	43 9½	44 2	44 7½	43 7	43 5	43 3	44 3½
1895	42 8	42 5½	42 6	42 10	43 10	43 7½	44 10	45 11	49 11	48 9	47 7½	47 7½	45 2½
1896	47 0	48 9	48 9	48 2½	47 3	47 3	46 10	46 10	47 2	48 5	50 7	50 6	48 1½
1897	51 2	49 10	48 5	47 4	47 9½	48 6	47 0	47 3	47 3	47 0	48 3½	47 11	48 2
1898	48 9	48 10	49 4	47 8½	50 10	50 3½	51 0	52 5	53 11	55 8	57 3	56 10	52 1½
1899	59 1	59 9	57 7	59 6	64 7	70 10½	76 7½	72 2	74 3	75 0	78 1½	73 3	68 5
1900	75 3½	76 10	79 10	84 6	81 4	79 1½	83 4	81 5	79 11	76 10	77 8½	68 4	78 8
1901	60 2	59 0	57 9½	57 6½	57 8	57 4½	57 8	61 0	60 0½	59 9	58 7½	56 7	58 7½
1902	56 1	57 9½	59 3½	59 9	59 10½	60 0	60 0	60 8½	61 5	61 2	59 3	59 0	59 6
1903	58 5	58 8	61 1	59 5	57 10	57 3	56 7	56 3	55 9	54 8	52 4	52 4	56 8½
1904	52 8½	53 1	53 7	54 9	54 2	53 2½	52 9	52 5	52 2½	52 7	53 1	55 11½	53 5½
1905	57 9½	56 9	58 1	58 2	56 4	55 8	55 5½	56 7	61 0	68 9	69 9	70 11½	60 5½
1906	70 4½	65 2½	63 4½	63 9	64 5	64 6	64 1	66 2½	67 3	69 4½	72 4½	78 8½	67 5
1907	77 9	72 11	71 10	73 9	79 9½	76 9	77 9	78 4	75 11	72 9½	68 6	66 7	74 4
1908	62 7	59 1	61 6½	61 6½	61 4	59 1	57 9½	56 11	60 2	59 2	58 5½	57 7	59 7½
1909	51 4	56 5	55 3	56 1	56 4	57 0	56 8	58 0	61 0	61 1½	60 7½	61 4	58 1½
1910	64 0½	64 3½	66 10½	67 6½	66 2½	65 4	64 4½	65 6½	65 2	64 10½	64 6	65 6	65 4½
1911	66 9	66 1	64 10	63 1	62 1	62 0	61 2	62 2	62 1	61 1	61 10	64 0	63 1
1912	67 0	67 0	67 0	69 3	71 9½	72 11	75 9½	79 1½	82 2½	85 0	85 3½	86 6	75 9½
1913	86 6	86 6	86 3	85 0	83 6½	80 10½	78 1	76 10½	72 6	71 0	68 0	65 3	78 4½
1914	64 6	65 4½	65 6	64 11½	64 2½	64 0	64 0	68 11½	74 6½	71 0	65 4½	69 9½	66 10½
1915	78 9	100 6	103 1	113 6	111 9	114 0	116 3	115 2½	113 8½	121 1½	131 9½	139 6½	113 3
1916	135 0	135 0	133 4	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	129 2½
1917	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6
1918	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6
1919	127 6	127 6	127 6	127 6	180 6	184 3	195 4½	204 6	204 6	204 6	204 6	204 6	174 7
1920	224 9	235 0	245 0	275 0	290 0	295 0	295 0	295 0	295 0	295 0	295 0	280 0	284 11½
1921	263 4	228 4	180 0	180 0	160 0	160 0	157 6	142 0	128 6	121 0	115 6	167 9½
1922	125 0	117 6	115 0	115 0	115 0	115 0	113 1½	104 0	105 0	105 0	106 3	110 0	112 1½

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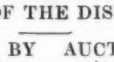
G.  R.

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